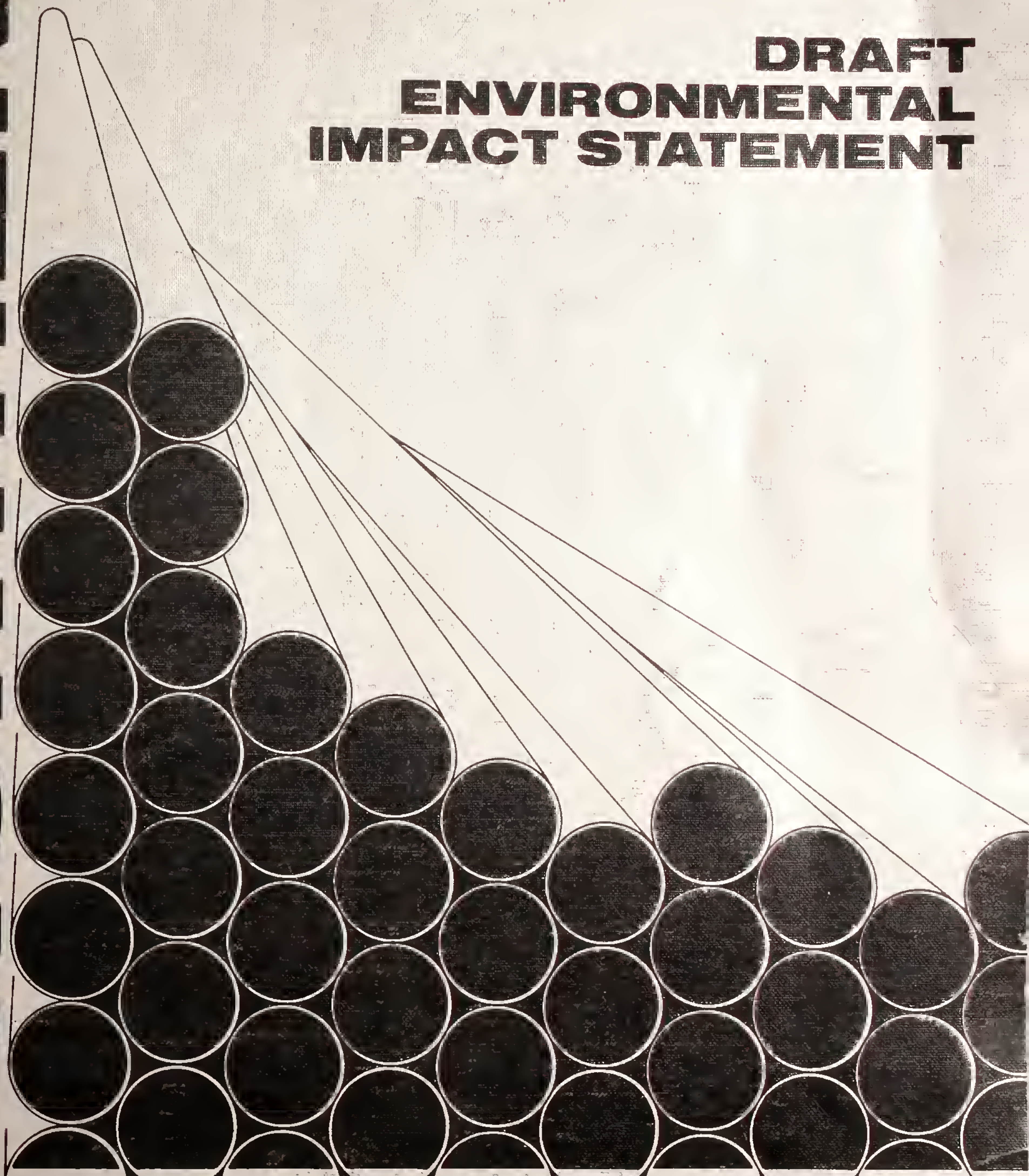
NORTHERN TIER

DRAFT ENVIRONMENTAL IMPACT STATEMENT



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32 SOUTH EWING, HELENA, MT 59601
(406) 449-3712

THOMAS L. JUDGE, GOVERNOR
TED J. DONEY, DIRECTOR

October 29, 1979

This Draft Environmental Impact Statement (EIS) concerns the proposed Northern Tier Pipeline as proposed by the Northern Tier Pipeline Company. Comments on the proposed project and on the EIS will be accepted for a forty-five (45) day period ending December 13, 1979. Please address written comments to:

Project Manager, Northern Tier Pipeline
Energy Division
Department of Natural Resources & Conservation
32 South Ewing
Helena, Montana 59601

Public meetings to gather comment on the EIS will be held according to the following schedule:

Helena -- November 26; 7:00 P.M.; new Highway Department Complex Auditorium.

Harlowton -- November 27; 7:00 P.M.; County Courthouse.

Circle -- November 28; 7:00 P.M.; Traveler's Inn basement meeting room.

Helmville -- December 3; 7:00 P.M.; Community Hall.

Thompson Falls -- December 5; 7:00 P.M.; Elementary School Multipurpose Room.

Missoula -- December 6; 7:00 P.M.; Hellgate High School Auditorium.

This Draft EIS was prepared in compliance with the Montana Environmental Policy Act, Section 75-1-201, MCA. On October 29, 1979, copies of this EIS were filed with the Governor and the Environmental Quality Council.

Sincerely,

Dave Janis, Project Manager
Northern Tier Pipeline

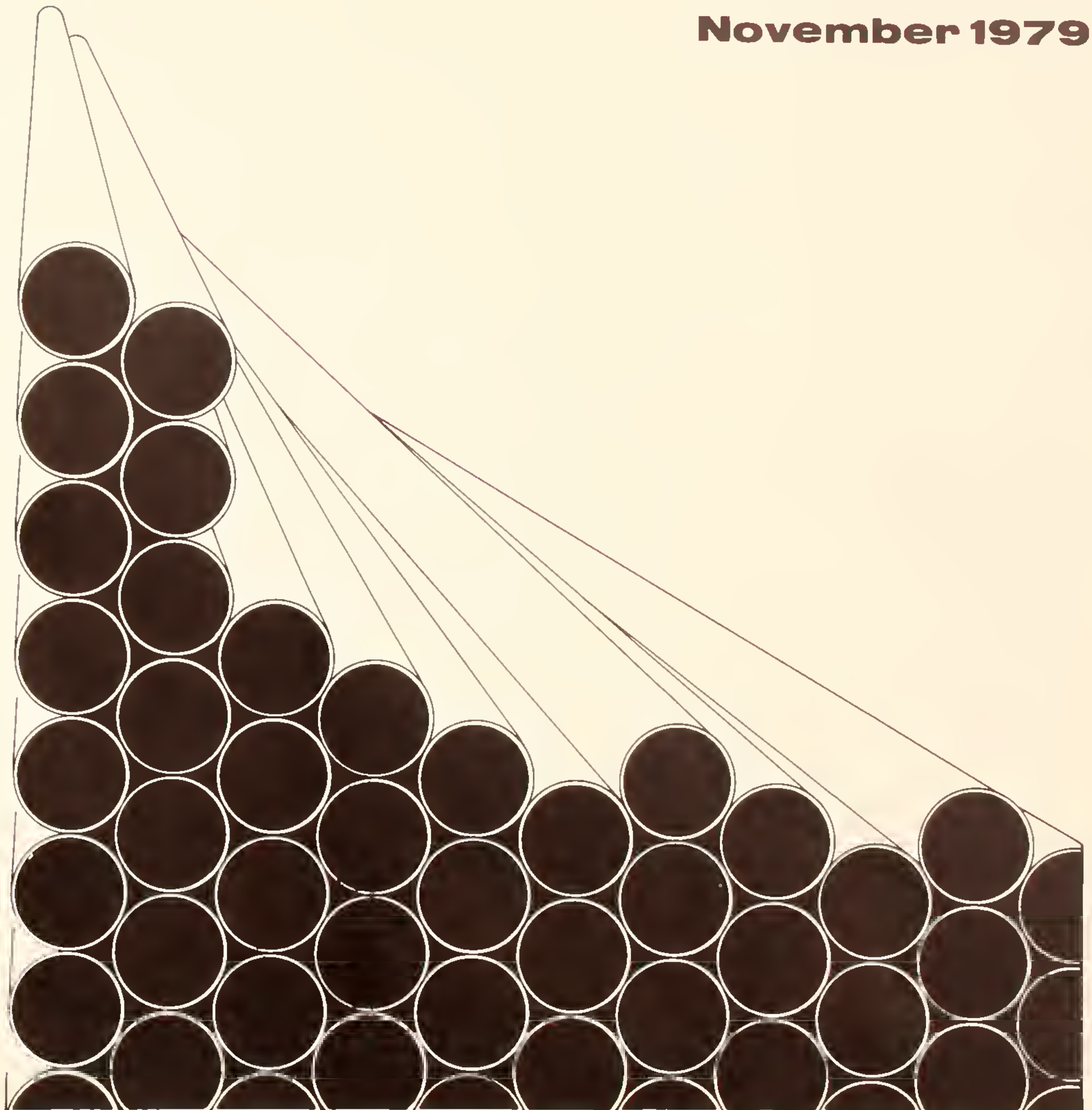
DJ/cab

Enclosure

DRAFT EIS on the

PROPOSED NORTHERN TIER PIPELINE SYSTEM

November 1979



MONTANA DEPARTMENT OF NATURAL RESOURCES AND CONSERVATION

Energy Division
(406)449-3780

32 South Ewing
Helena, MT 59601

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DRAFT EIS

SUMMARY

The Montana Environmental Policy Act (MEPA) requires that an environmental impact statement (EIS) be published concerning any major proposed action of state government that may significantly affect the quality of the human environment. One such action is the granting by the state of permits and easements to the Northern Tier Pipeline Company (NTPC) for its proposed crude oil pipeline. The purpose of this EIS is to inform the state permitting agencies and the public of the potential impacts, both adverse and beneficial, that the proposed Northern Tier Pipeline could have on Montana's social, economic, and natural environment. Also considered are alternatives to the proposed pipeline system, alternative routes investigated by the Department of Natural Resources and Conservation (DNRC), and measures that could be taken to mitigate potential adverse impacts. DNRC was appointed lead agency in preparing this EIS and is responsible for consulting with other agencies, including those involved in issuing permits for the proposed pipeline.

The document you now hold is a **draft** EIS; it is a part of the decision-making process. The state has not yet endorsed a route or recommended permit conditions. During the comment period following the release of this draft EIS, comments concerning the report will be accepted from the public, NTPC, and government agencies. Appropriate comments and responses will be included, along with the state's recommendations and pertinent information received after release of the draft EIS, in a **final** EIS. State agencies may not act on NTPC's applications for state permits sooner than thirty days after the final EIS is transmitted to the Governor and the Environmental Quality Council.

DNRC issued six reports to supplement and support this draft EIS; these are identified and discussed on p. 8. Information found in the federal draft EIS on the proposed system (USDI 1979) was used whenever possible in preparation of the state's EIS.

DESCRIPTION OF THE PROPOSED PROJECT

NTPC proposes to build a common-carrier crude-oil pipeline across Washington, Idaho, Montana, North Dakota, and Minnesota for the purpose of moving Alaskan North Slope and foreign crude oil to inland states to make up for anticipated shortages. The proposed Northern Tier Pipeline System would include unloading facilities for receiving oil by tanker at Port Angeles, Washington; two submarine pipelines to connect the unloading berths to an onshore storage facility northeast of Port Angeles at Green Point, Washington; and a 2,399-km (1,491-mi) underground pipeline terminating at Clearbrook, Minnesota. The system, which would cross approximately 1,014 km (630 mi) of state, federal, and private land in Montana, would be capable of transporting 113,000 m^3 (709,000 barrels) of crude oil per day initially and an anticipated 150,000 m^3 (933,000 barrels) per day within five years of beginning operation. (One barrel equals 42 U.S. gallons.) Approximately 50 percent of the initial throughput is expected to be Alaskan North Slope crude oil, with the remainder coming from foreign sources.

The delivery facilities at Clearbrook would provide crude oil to a major pipeline network transporting oil to refineries in Midwestern and Eastern states. There would also be delivery facilities in North Dakota and in Montana, where the pipeline would connect to the Glacier Pipeline near Harlowton and the Western Crude Oil Pipeline near Richey. NTPC proposes a temporary 27-m (90-ft) construction right-of-way, and a permanent right-of-way of 23 m (75 ft) for state and private land. Of the twenty-two pump stations that would be needed for the project, seven would be in Montana, two of them located at the delivery facilities near Harlowton and Richey. Transmission lines would be needed to provide power for the pump stations and delivery facilities. All of these facilities and the right-of-way would require a commitment of land for the life of the project.

Construction of the pipeline and associated facilities would be accomplished on ten construction sections operating simultaneously across the five states; all or part of five of these sections would be in Montana. When completed, the entire system would be operated by remote control from the Green Point storage facilities in Washington. NTPC has projected a twenty to twenty-two month construction and testing period, with the entire system in operation by the fall of 1981. The projected life of the pipeline is at least twenty years.

NTPC's project cost estimate in May 1978 dollars is $1,152,131,000. Project costs in Montana are estimated at $399,728,000.

SYSTEM ALTERNATIVES

MEPA requires that, in preparing an EIS, the state study the environmental effects of the proposed action and of alternatives to it. One of the alternatives stipulated in the Act is the alternative of taking no action—in this case, of not building a crude-oil transportation system. To evaluate this alternative, it is necessary to consider the need for the proposed project. Other alternatives considered were of two types: (1) alternative means of securing crude oil for Montana refineries, and (2) alternative pipeline routes.

Need

The question of Montana's need for the proposed pipeline, or for any other crude-oil transportation system, is a question of supply and demand: Without the proposed facility, will the demand for crude oil in Montana exceed supply? If so, will the proposed facility reduce or eliminate that shortfall in crude oil supply? Projecting future supply and demand is complicated by a number of variables, requiring that assumptions be made about future conditions. The assumptions made for this analysis were that there would be no new pipeline construction, that there would be access only to local production at the historical percentage level, that no other attempts would be made to augment crude supplies in Montana, that domestic crude prices would rise to world levels as a result of deregulation, and that demand would be as projected by studies done independently of DNRC.

Based on these assumptions, DNRC's analysis concludes that additional crude will be needed by 1980 to enable Montana's refiners to continue operating economically. Even if all refiners were able to continue operating at capacity, they might not be able to supply the increased demand for refined product in their service area. If this refined product demand is to be met, crude must be available to allow Montana refining capacity to expand, refined products must be shipped into the service area from outside, or refining capacity must be constructed in the service area outside Montana.

Alternative Means of Securing Crude Oil for Montana Refineries

Historically, Montana refineries have been dependent on Canadian crude oil for a large portion of their total crude supply. In 1970, Canadian crude comprised 22 percent of Montana's total supply and in 1977, 43 percent. Canada presently intends, by 1982, to stop exporting light crude oil, the type traditionally received by Montana refineries.

Because Montana refineries are isolated from any major crude-oil transportation system, they are limited to Montana, Wyoming, and Canada as sources of crude. The loss of any sources, if not replaced, would cause problems, including the possible forced closure of one or more refineries and potential shortages of refined products in their service area.

Several alternatives are available to compensate the probable loss of Canadian crude exports to Montana, including some that would require construction of new transportation facilities and some that would not.

The construction alternatives are the Northern Tier Pipeline, Trans Mountain Pipeline, Kitimat Pipeline, Alaska Highway Oil (Foothills) Pipeline, and GATX Unit Train proposals. The Northern Tier Pipeline apparently would provide the lowest delivery cost; the Kitimat Pipeline would provide the next lowest, followed by the Trans Mountain Pipeline.

One of the nonconstruction alternatives is the reallocation of crude flows, which involves retaining more of Montana crude for refining in Montana (about 73 percent is currently being exported to other states) and maintaining crude exchanges with Canada. (Exchanges are not considered exports by Canada, and Canada currently has no intention to discontinue them.) Because this alternative uses existing transportation facilities, it is the least expensive of the major alternatives.

In comparing alternative solutions, there are other factors to consider besides the monetary expense. Determining the most beneficial alternative is a political and social decision involving the tradeoff between security of supply and environmental considerations. Environmental considerations make the reallocation of crude flows a more attractive alternative than the Northern Tier Pipeline and therefore reinforce its monetary advantage. However, reallocating crude flows involves dependence on Canadian crude exchanges which may make a crude supply obtained through this alternative less secure than one obtained through the Northern Tier Pipeline. If security of supply is considered important enough to outweigh environmental considerations and the monetary expense advantage, then the Northern Tier, Kitimat or Trans Mountain pipelines would be more desirable then reallocation. The choice between the Northern Tier Pipeline and the Kitimat or Trans Mountain pipelines involves monetary cost—in which the Northern Tier Pipeline has an advantage—and environmental damage—in which the Kitimat, Alaskan Highway (Foothills) and Trans Mountain pipelines have an advantage (at least in Montana, since these three do not involve construction in the state). All would offer the same security of supply.

Alternative Pipeline Routes

If the Northern Tier Pipeline appears to be the most beneficial alternative, then routing is the next important consideration. DNRC began with NTPC's proposed and alternative routes and identified additional corridors which were thought to be reasonable alternatives. After these corridors had been examined by other state, federal, and local agencies, the corridor boundaries were modified and the environmental, social, and economic concerns within the corridors were studied. Alternative routes within those wide corridors were then identified where it was felt that pipeline construction would be least disruptive and expensive.

With one exception (the St. Ignatius Route), all routes pass through the narrow Clark Fork Valley at Bonner, and any route west of Bonner could be paired with any route east of Bonner. The routes which DNRC examined in detail are described below; more detailed route descriptions and the potential impacts of constructing the pipeline along these routes are discussed in appendix G. The routes are compared and evaluated in chapter seven.

Routes West of Bonner

Northern Tier Proposed Route. This route enters Montana at Thompson Pass and follows Prospect Creek to the Clark Fork. It follows the Clark Fork Valley past Plains and Paradise, crossing the river three times, to the mouth of Siegel Creek, climbing the canyon of this creek to Siegel Pass. Then it follows Ninemile Creek back to the Clark Fork near Frenchtown and continues north of the Clark Fork to Bonner.

DNRC Modification Route. This route follows the same general path described above for the Northern Tier Proposed Route, with a few minor adjustments for environmental or other reasons.

Arlee Route. This route is identical to the Northern Tier Proposed Route from the Idaho border to Weeksville. From there it proceeds southeast to Perma, crosses the Flathead River, and parallels the river to Dixon. It then roughly follows Highway 93 to Missoula and rejoins the Northern Tier Proposed Route.

Knox Pass Route. This route deviates from the Northern Tier Proposed Route southwest of Thompson Falls. It follows Dry Creek and Knox Creek to Knox Pass; from there, it follows Twelvemile Creek to St. Regis, then follows Interstate 90 to Frenchtown, where it rejoins the Northern Tier Proposed Route.

Routes East of Bonner

Northern Tier Proposed Route. From Bonner, the Northern Tier Proposed Route follows the abandoned Milwaukee Railroad right-of-way to the McNamara Bridge, where it crosses the Blackfoot River and heads southwest to the Copper Cliff Mine (on the crest of the Garnet Range, south of Potomac) and eastward over the Garnet Mountains. It follows the Douglas Creek drainage into the Nevada Creek Valley near Helmville and crosses the divide near Greenhorn Mountain. It follows Sevenmile Creek to Helena, parallels Custer Avenue just north of the city limits, and follows Highway 12 to Townsend, where it crosses the Missouri River. From there, it crosses the Big Belts, passes near Ringling, and continues to North Dakota via Martinsdale, Flatwillow, Mosby, and Bainville, where it crosses the Missouri a second time.

DNRC Modification Route. This route has three deviations from the Northern Tier Proposed Route, only two of them major. From the Copper Cliff Mine, this route follows a Montana Power Company transmission line and Tenmile Creek to Bearmouth and, from there, follows the Yellowstone Pipeline right-of-way to Avon, crossing the Clark Fork twice. It rejoins the Northern Tier Proposed Route north of Avon. In eastern Montana, this route leaves the Northern Tier

Proposed Route east of Jordan to parallel Highway 200 past Circle and Richey; near Richey, it diverges from the highway and heads northeast to rejoin the Northern Tier Proposed Route.

Hi-Line Route. This route leaves the Northern Tier Proposed Route near McNamara Bridge, heading north through two unnamed passes into the Blanchard Creek drainage, which it follows to Clearwater Junction. From there, it roughly parallels Highway 200 past Lincoln, crosses the divide northwest of Rogers Pass, and heads northeast to Havre, roughly paralleling Highway 27 for much of that distance. From Havre, the route proceeds almost due east, entering North Dakota near Dagmar.

Raynesford Route. This route is identical to the Hi-Line Route from Bonner to Birdtail Butte, west of Cascade. There it turns east and passes near Raynesford, Denton, Christina, Roy, and Wild Horse Lake, to join the DNRC Modification Route at Mosby.

St. Ignatius Route

This is the only alternative route which does not pass through the Bonner area. It is identical to the Northern Tier Proposed Route from the Idaho border to Weeksville. From there it crosses the lower Flathead Valley to St. Ignatius, follows a Montana Power Company transmission line across the Mission Mountains to Ovando, and rejoins the Northern Tier Proposed Route at Helmville.

ENGINEERING CONCERNS

Engineering Design

DNRC evaluated the conceptual design of the proposed Northern Tier Pipeline as submitted by NTPC; NTPC has not yet completed its detailed design.

NTPC has proposed trenching all stream crossings; DNRC suggests that other methods, including aerial and drilled crossings, be examined. With proper design and construction, all of the crossing methods are nearly equal in reliability, although trenched or drilled crossings involve slightly less risk of damage than do aerial crossings. The environmental impacts of the several methods differ greatly, though, and some would be far better at particular sites than others. Specific recommendations for crossing methods should be made during centerline selection.

NTPC's material specifications for the manufacture of pipe, as presently proposed, are more stringent than government regulations or industry codes.

Geotechnical Concerns

DNRC investigated the geologic concerns relevant to engineering on the routes and identified as problems only landslide areas (most of which can be avoided), a number of nonrippable, hard-bedrock areas, and the Intermountain Seismic Belt, an active earthquake zone that includes western Montana. Several earthquakes of Richter magnitude 6 and one of magnitude 7 have been recorded in this zone; future similarly sized disturbances can be expected.

The chance of damage to the above-ground facilities of the Northern Tier Pipeline System is probably greater than the chance of damage to the pipe. A review of the limited available information regarding damage to modern crude-oil pipeline systems found that although above-ground facilities have been damaged, there is no evidence of damage to buried pipe. Significant earthquake damage has occurred to utilities and other types of pipeline systems that were not properly designed.

In the Three Forks region, the Helena-Lincoln region (including the Townsend area), the Nevada Valley, along the Ninemile Fault west of Missoula, and possibly along the Hope Fault east of Thompson Falls, special investigation of fault location and movement and appropriate earthquake-resistant design would be advisable.

Right-of-way Width

NTPC proposes a 23-m-wide (75-ft-wide) permanent easement and cleared right-of-way on state and private land, and a 16-m-wide (54-ft-wide) permanent easement and cleared right-of-way on federal land. (The latter width is the maximum allowed by federal law on federal land.) However, the amount of land actually required could be less than these widths; depending on local conditions, a cleared width as narrow as 9 m (30 ft) could be adequate for maintenance access and inspection.

Oil Spills

Despite all precautions, oil spills will probably occur; table 27, p. 50, summarizes the relative risks of several causes of spills. The most probable causes are (1) accidental rupture of the pipe by equipment such as excavation machinery striking the pipe, and (2) improper operation of the system, such as a valve being left open. Pipe coating and cathodic protection has drastically reduced corrosion, historically one of the major causes of leaks; to be effective, these measures depend on quality-control programs, such as shop and field inspection of pipe coating and laying, and on regular maintenance of the cathodic system. Experience on the Trans Alaskan Pipeline has shown a definite need for third party inspection.

NTPC's leak detection system, as proposed, is designed to detect a leak as small as 0.5 percent of the throughput volume. The system is only accurate enough to identify the two control stations between which the leak occurs. The block valves must then be closed and the line temporarily shut down. If, however, there were a rupture severe enough to spill all of the oil between the block or check valves the maximum distance apart, the spill could be as large as 10,174 m^3 (64,000 barrels).

IMPACTS AND MITIGATING MEASURES

Thirteen areas of environmental, social, and economic concern were identified for use in evaluation of the potential impacts of the proposed pipeline. These impacts are discussed below for each of the thirteen areas of concern.

Terrain, Engineering, and Hydrologic Constraints

Construction difficulty is related to soils, river crossings, wet areas, rock areas, and slope. For the routes west of Bonner, these factors are comparable. Ranking these routes according to relative cost (a function of length, terrain, and horsepower requirements for pumping) shows the Northern Tier Proposed Route to be slightly more economical than the DNRC Modification Route, the Knox Pass Route next, and the Arlee Route far more expensive than the others.

The four east-of-Bonner routes are also roughly equal in construction difficulty. Projected cost differences between these four routes are small enough to be of little use in route comparison. The St. Ignatius Route does not significantly differ from any combination of the other in construction difficulty.

Earthquake Hazards

A general discussion of earthquake hazards to the proposed pipeline is found in the preceding section.

West of Bonner, seismic risk along the four routes is low and roughly equal; there is more risk along the Arlee Route. East of Bonner there is considerably greater seismic risk, but again the routes are roughly equal, with the exception that the Northern Tier Proposed Route and the DNRC Modification Route cross precipitous terrain and would more likely be subject to earthquake-induced landslides than would the other two routes. Earthquake hazard is low east of the mountains. The St. Ignatius Route is approximately equal in seismic risk to the others.

Geologic Concerns and Mineral Resources

No geologic features of unique or unusual scientific, educational, or public interest were identified. Also, there are no known

low-grade metallic mineral deposits (other than small placer gold deposits in western Montana) subject to large-scale open-pit mining along any of the routes.

Construction of the pipeline across a strippable mineral resource would preclude mining of that mineral beneath the right-of-way, and may significantly increase extraction costs near the right-of-way. The most effective way to mitigate potential impacts on the geologic environment or on mineral resources would be to avoid known geologic and mineral resource areas. This could be done successfully along any of the proposed pipeline routes, except for areas of strippable lignite in northeastern Montana along the Hi-Line and Raynesford routes.

West of Bonner, the Arlee and Knox Pass routes are comparable and slightly superior to the Northern Tier Proposed and the DNRC Modification routes, assuming that potential hazards to the pipe are considered more important than those geologic factors that affect construction difficulty and cost. Crossing only a short distance of hard bedrock, the Raynesford Route is clearly the best route east of Bonner. The DNRC Modification Route is the least desirable, while the Hi-Line and the Northern Tier Proposed routes are roughly equal. The St. Ignatius Route is slightly better than any combination of the other routes when considering geologic concerns, because it has no known landslide or slump areas and less than 1 km (0.6 mi) of cliff area.

The route eventually selected may inadvertently cross mineral deposits not yet identified or not publicly disclosed by private companies; careful centerline studies by NTPC might avoid this situation, insofar as possible.

Impacts on Land Use

The greatest impacts on land use would result from restrictions placed on the right-of-way and from the loss of land to pump stations, delivery facilities, and other associated facilities. Oil spills may intensify these effects. Siting pump stations and other associated facilities with compatible land uses—such as in existing industrial areas—would be an effective mitigating measure.

The major legal constraint affecting the alternative routes is the necessity for approval by the tribal council of any route crossing the Flathead Indian Reservation. The Arlee Route and the St. Ignatius Route would both require such approval.

Because of the variation of land uses, no attempt was made to rank the routes in order of desirability.

Impacts on Social and Economic Concerns

Construction-period impacts would include a relatively large influx of construction workers (and some dependents) into relatively sparsely populated areas; consequently, housing and services would be strained. Establishment of construction camps may be the most effective mitigating measure. The construction employment for Montanans, estimated at between 300 and 400 person-years, would be a positive impact, as would the induced (secondary) income effects. The only significant long-term impact would be the increased tax income available to local taxing jurisdictions and the increase in corporate income tax revenues to Montana.

West of Bonner, no route stands out clearly as the best from a socioeconomic point of view; each route has both advantages and disadvantages. The Knox Pass Route, for instance, would result in the highest permanent loss of land productivity of the four routes, but would also result in the highest estimated property tax revenue. The routes east of Bonner are also similar in socioeconomic impact. The St. Ignatius Route is little different from any combination of the others, with the exception that housing shortages for construction workers would be most severe along this route.

Impacts on Cultural Resources

Cultural resources are defined here as physical evidence of prehistoric activities or important historic events and as the locations of recorded historic events. If resources in the path of the pipeline are not identified and avoided by centerline adjustment before construction, they would probably be displaced, damaged, or destroyed. An intensive inventory would be required to avoid damage to cultural resources along the routes.

Impacts on Visual Quality

In forest lands, where the clearing of trees and shrubs along the pipeline right-of-way would make a linear strip of deforested land visible from overviews or from road crossings of the right-of-way, long-term visual impacts would be adverse and significant. Little could be done to mitigate this problem; the route could be curved or bent to eliminate long, straight stretches, and screening shrubs could be planted wherever roads cross the right-of-way.

Significant but short-term visual impacts, including destruction of vegetation, generation of dust, and operation of machinery in scenic areas, would result from construction operations.

The free-span aerial bridges (with towers approximately 90-m-high or 300-ft-high) that may be used to cross rivers would produce a significant visual impact if located in scenic areas. NTPC has not proposed using aerial bridges, but DNRC has examined the feasibility of using them at crossings with sensitive aquatic resources. At trenched crossings, which are proposed at all rivers by NTPC, long-term visual impacts would be significant where there is extensive riprapping, tree removal, and related bank disturbance.

There would be negligible long-term visual impact to cropland and, except where reclamation fails, to rangeland.

Appropriate design and siting of pump stations, delivery facilities, and electrical service lines would partially mitigate the visual impacts of these structures.

Construction on any of the four routes west of Bonner would result in significant, long-term visual impact, since each passes through dense forest (including recreational areas and U.S. Forest Service specially managed areas) and scenic canyons. There is no real difference in potential visual impact among the four routes, other than the crossing by the DNRC Modification Route of a scenic series of cliffs and steep talus slopes north of the Clark Fork between Thompson Falls and Plains. The differences among the four routes east of Bonner are not significant enough to be of use in route comparison. Visual impact on the St. Ignatius Route is roughly equal to that of any combination of the others.

Impacts on Soils

The most significant adverse impact to soils would result from: soil loss during construction and reclamation, when large areas are devoid of vegetation; horizon mixing; and, for some soils, soil compaction. Where reclamation is not successful, plant growth would be hindered or erosion rates increased.

NTPC proposes to store topsoil separately from subsoil during construction; this procedure, coupled with reclamation measures aimed at the rapid reestablishment of ground vegetation after construction, would significantly reduce the long-term impacts to soil.

Spilled oil from a leak in the pipe would generally work its way upward to the ground surface soon after the leak begins and flow across the ground, contaminating the soil. Appropriate and timely cleanup and reclamation measures would help reduce long-term effects to low but not negligible levels; these measures would require conscientious followup and, possibly, replacement of topsoil in severely damaged areas.

West of Bonner, the Arlee Route has the least potential for soil erosion of the four; it crosses less land of high erosion potential, fewer streams, and less steep, forested country. The Northern Tier Proposed Route, the DNRC Modification Route, and the Knox Pass Route are about equal in soil erosion potential. Similarly, east of Bonner, the Hi-Line Route would result in the fewest soil problems, with the other three about equal. The least-impact combination of the Arlee and Hi-Line routes has 51 km (32 mi) less terrain with high-impact potential than does the St. Ignatius Route.

Impacts on Aquatic Life and Habitats

Adverse impacts to aquatic resources are most likely to result from petroleum contamination, sedimentation, suspended sediment, and alteration of stream channels and streambanks.

Petroleum contamination of waterways is likely during both construction and operation of the pipeline. The degree of harm on an aquatic environment by a spill would depend on the type of waterway and the effectiveness of cleanup. An oil spill into water has the potential to cause long-term impacts, particularly when the volume of water involved is not large enough to dilute the spilled oil below concentrations toxic to fish and other aquatic life.

Short-term adverse impacts from sedimentation and suspended sediment would occur where a pipeline right-of-way or road crosses a stream. These impacts could be long term if bank restoration or right-of-way maintenance near streams and drainage channels produces erosive conditions. With proper mitigation, however, impacts from sedimentation and suspended sediments would probably be short term.

Stream channels and banks would be altered by this project. Adverse impacts resulting from vegetation removal along streambanks could be long term if cover and shade were not restored. Inadequate or improperly installed drainage structures for permanent access roads would create long-term impacts because of increased erosion, blocked fish passage, and washouts. Installation and removal of culverts on temporary roads would have short-term adverse impacts because of sedimentation and streambed disruption.

Properly chosen mitigating measures, if conscientiously adhered to, would prevent long-term impacts to aquatic life and habitats. Four effective measures would be (1) constructing stream crossings in as short a time as feasible, (2) constructing crossings at the time of year when impacts would be least, (3) avoiding crossings in biologically sensitive areas, and (4) rapidly revegetating banks and the cleared right-of-way.

West of Bonner, the Knox Pass Route would result in the greatest disturbance to aquatic habitats. The Northern Tier Proposed Route and the DNRC Modification Route are similar in this regard, and the Arlee Route probably presents the least potential for impacts to aquatic life and habitats. East of Bonner, the routes are not significantly different. The DNRC Modification Route, because it involves two more Clark Fork crossings and several other important stream crossings, is inferior to the Northern Tier Proposed Route. The Hi-Line Route avoids two Missouri River crossings and a Blackfoot River crossing, but affects many more streams in the Blackfoot drainage than either the DNRC Modification Route or the Northern Tier Proposed Route.

The Raynesford Route crosses the Missouri River twice and would have the same impacts on the Blackfoot drainage as does the Hi-Line Route. If the crossings of the Missouri River were directionally drilled, the Northern Tier Proposed Route would be the preferred route.

Because it crosses fewer streams and closely parallels fewer kilometers of streams than does any combination of the other routes, the St. Ignatius Route would have the least impact on aquatic life and habitat.

Impacts on Ground Water

Oil spills could significantly contaminate shallow ground water—that less than 23-m-deep (75-ft-deep)—in the vicinity of the spill. Spills from complete ruptures of the pipe, and most but not all smaller spills, would surface and could then be detected. Small leaks that go undetected for long could contaminate large volumes of ground water before detection. In all cases, the extent of contamination would depend on local topography and subsurface permeability. Local, minor degradation of shallow ground-water quality could occur during construction and testing of the pipe system.

Ground water deeper than 23 m (75 ft) would be unlikely to be affected by either pipeline construction or oil spills.

Health hazards to adult humans from consuming oil-polluted water from wells are unlikely because such water becomes objectionable in odor and taste long before it reaches toxic concentrations. There is no information available on the likelihood or effects of animals drinking oil-contaminated water from wells. Oil contamination of shallow ground water could cause that water supply to be declared a health hazard.

Where there is high-quality, shallow ground water in permeable soil, trench designs that would force leaking oil to seep upward could be used. Also, site-specific geologic information could be gathered **before** final design of the pipeline, to better formulate spill response plans.

Considering the potential impacts to ground water of the routes west of Bonner, the Northern Tier Proposed Route and the Knox Pass Route are the least desirable, and the Arlee Route and the DNRC Modification Route are approximately equal and significantly better than the other two. East of Bonner, none of the differences among the four routes are significant in route comparison. In ground-water risk, the St. Ignatius Route is considerably worse than any possible combination of west and east routes.

Impacts on Vegetation and Land Productivity

Because of the long-term effects of rights-of-way and associated facilities on timber productivity, impact risk is greatest in coniferous and riparian forests. One effective measure to mitigate the impact of the pipeline on land productivity would be to cross as little forested land as possible; for instance, existing cleared rights-of-way could be used where possible. Because cropland can be reclaimed faster than forest or rangeland, it is, relatively, a better place to route a pipeline.

Considering the total amount of forested land crossed, the best route west of Bonner would be the Arlee route and the best route east of Bonner would be the DNRC Modification Route; St. Ignatius would be the least desirable when compared to any combination of the others. Considering the length only of highly productive forest habitat types crossed, the best route west of Bonner would be the Arlee Route; either the Hi-Line or Raynesford routes would be the most desirable east of Bonner.

Impacts on Wildlife and Habitats

The most significant potential impacts of the Northern Tier Pipeline are: (1) long-term habitat alteration resulting from prevention of regrowth of trees and shrubs on the permanent right-of-way; (2) intrusion of the right-of-way or access roads (if any) into roadless security areas; (3) long-term habitat alteration resulting from the presence of pump station and delivery facilities; (4) permanent abandonment of special-use sites (raptor nests, sage grouse strutting grounds, sharp-tailed grouse dancing grounds, large water bird colonies) due to pipeline construction or maintenance; and (5) major oil spills in wetlands during periods of heavy use by water birds.

The most effective mitigation would be avoidance of such areas as special-use sites, wetlands, forest land, and roadless security areas. If such areas cannot be avoided, construction and maintenance could be carefully planned and monitored to take place when they would cause the least damage.

Because of the great variation in habitat required by different species, and because many species require several types of habitat for different purposes and at different times of the year, any of the routes would result in adverse impact on wildlife. Some routes would cross less habitat of particular species than would others. Table 49, p. 106, shows which routes would result in the least impact on species of concern in Montana.

Impacts on Climate and Air Quality

The probability of any long-term impacts on climate from the proposed pipeline is low. Major air quality impacts would also be unlikely; however, localized minor impacts may be noted during construction and operation. Air pollutants would be produced during pipeline construction and an in-

crease in fugitive dust levels would also occur.

There is no difference among the routes considering potential impacts on climate and air quality.

CONFLICTING CONCERNS

In the comparison of alternative routes in the preceding section, no particular route seems clearly the best. The route with the least potential for impact on one concern would likely result in a greater impact on another. Likewise, if NTPC were to select construction techniques for maximum speed and economy, those techniques would likely have a greater impact on the environment than would those chosen for minimum environmental impact. And even among the mitigating measures discussed in this EIS, there are conflicts between concerns. For instance, keeping the right-of-way as narrow as possible would damage less land, but could slow construction and hinder the movement of equipment to an oil spill.

Because there are conflicts between them, not all of the concerns discussed in this EIS could be equally protected during construction of the proposed pipeline. But it is likely that some of those concerns are of greater importance to the people of Montana than are others. The route recommended by DNRC should protect these important concerns, even if some of the less important concerns would be significantly and adversely affected. A decision to protect one resource and not another, or to select one route because of an advantage it offers even though it also has disadvantages, is called a "tradeoff."

The selection of a centerline, probably more than any other decision, will determine the severity of the pipeline's impact on Montana's environment; but the selection of construction techniques and mitigating measures will also be important. All of these decisions involve tradeoffs, and all of these tradeoffs can be influenced by public comment. During the comment period preceding DNRC's preparation of a final EIS, governmental agencies, private enterprise, and private citizens will be encouraged to make their thoughts known concerning the proposed pipeline and the hard choices—the tradeoffs—between routes, between resources, between potential impacts. DNRC will consider all such comments in making its recommendations.

Public comment is needed on the following key questions:

1) Is a major east-to-west pipeline system, such as that proposed by NTPC, needed?
2) If such a pipeline is needed, is the Northern Tier Pipeline the best of the alternatives from an environmental, economic, and social standpoint?
3) Which of the pipeline routes identified by NTPC and DNRC is the most environmentally, socially, and economically acceptable to the permitting agencies and the people of Montana?
4) How involved should the state be in centerline selection?
5) How involved should the state be in monitoring construction and reclamation?

Some of the more important tradeoffs involved are:

1) Is it better to cross several small streams to avoid a major river crossing?
2) Are the long-term visual impacts of aerial crossings more desirable than the shorter-term aquatic impacts of trenched crossings?
3) Is a narrower right-of-way better because fewer impacts would result, although it may slow construction time and could slow equipment moving to an oil spill?
4) Since distance is a factor in oil spill risk, is it better to cross a stream or river and then route away from it, or should the route parallel the river or stream and avoid the crossing?
5) There are tradeoffs among the impacts to wildlife habitat. Is it better to save an eagle's nest but harm critical elk winter range?

This list of tradeoffs is not complete, but it does give the reader a better idea of the types of tradeoffs that the DNRC is seeking public comment on.

Through the issuing of permits and the attaching of conditions to those permits, there can be governmental control of some tradeoffs—for example, it could be a permit condition that each stream crossing would be done in a particular way. Over other tradeoffs, state authority is not clear. In either case, it is important that public comment be gathered. Such comment may influence the resolution of many of the tradeoffs, either by helping to shape DNRC's recommendations in the final EIS or by prompting written agreements between NTPC and landowners.

CHAPTER ONE

INTRODUCTION

The Montana Environmental Policy Act (MEPA) requires that an environmental impact statement (EIS) be published evaluating any state action that significantly affects the quality of the human environment. After it is determined that an EIS is necessary, the EIS process must be completed before the state can act on permit applications.

The state of Montana determined under MEPA that an EIS is necessary on the proposed Northern Tier Pipeline, which would cross approximately 1,014 km (630 mi) of state, federal, and private land in Montana. Even though the Department of Natural Resources and Conservation (DNRC) does not have ultimate regulatory authority over the pipeline, Governor Judge (on July 27, 1977) appointed it lead agency for this EIS because DNRC has developed corridor-selection expertise in its evaluation of proposed transmission lines under the Montana Major Facility Siting Act. The proposed pipeline does not fall under this Act because it does not connect with any facilities as defined in the Act.

DNRC's primary responsibility as lead agency is to prepare an EIS that will help facilitate the environmentally sound siting of the Northern Tier Pipeline in Montana, if it is approved by the permitting agencies. As part of this responsibility, DNRC coordinates the efforts of all state agencies involved in the permitting processes. Table 1, p. 8, lists the state agencies' responsibilities and the permits which NTPC must have prior to construction. Locally issued permits are not included.

A federal draft EIS on the proposed pipeline system has been done by the Bureau of Land Management (BLM) and was issued in January 1979 (USDI 1979). Data from the BLM study has been used in preparing this EIS. The BLM final EIS was issued in August 1979.

TITLE V OF THE PUBLIC UTILITY REGULATORY POLICIES ACT OF 1978

The Public Utility Regulatory Policies Act of 1978 (P.L. 95-617), contains Title V which specifies that the President of the United States should approve a transportation system for moving Alaskan and other crude oil to northwest and inland states. Title V allows for waiver of all or part of federal law to facilitate construction of such a system, if proposed by the President and approved by a joint resolution of the U.S. Congress.

Title V would not directly affect Montana's permitting process as it relates to NTPC's proposal; however, it may limit the scope of the state's action. For example, the Montana Historical Society has no direct authority over NTPC. Should NTPC receive an easement across federal land, federal law would require a cultural-resources survey of the easement, and that survey would be subject to the Historical Society's approval. Likewise, the State Board of Land Commissioners can require such surveys before approving easements across state land. But if the federal authority to require a cultural-resources survey were waived in the case of NTPC, the Montana Historical Society could not require NTPC to survey the federal portions of the route. Consequently, only those portions of the route crossing state land would be surveyed, and then only if stipulated by the Board.

SCOPE OF THE EIS

MEPA requires that certain concerns be addressed in an EIS. These include:

1) Alternatives to the proposed action
2) Unavoidable adverse environmental effects
3) The relationship between local short-term uses of the environment and the maintenance and enhancement of long-term productivity
4) Irreversible and irretrievable commitments of resources
5) Growth-inducing or inhibiting impacts resulting from the project

Although MEPA does not mandate determining need, it does require that the state examine the implications of not building the proposed system as an alternative to the project. It is impossible to determine the impacts of nonconstruction without considering the need for the services provided by the pipeline. Therefore, chapter four of this EIS includes a discussion of need and of construction alternatives, and a cost-benefit analysis.

Alternative routes to NTPC's proposed route across Montana are also examined in the EIS. Impact risk to the alternative routes and to NTPC's proposed route was studied and is discussed in chapter six, along with possible mitigation for minimizing impact. The routes are evaluated in chapter seven.

If NTPC receives its permits, a route will be agreed to by NTPC and DNRC. Centerline selection—that is, determining the exact location of the line—would then be done. The state has proposed that DNRC and NTPC jointly evaluate the centerline after it has been staked and surveyed by NTPC. Site-specific information would then be gathered and evaluated, and centerline adjustments made. A description of the centerline study is included in appendix C.

Chapter five of the EIS evaluates NTPC's system design and proposed construction methods. It also describes other possible construction methods and mitigation to

minimize potential impact. Although NTPC does not plan on building any new access roads, new roads may be necessary if any of the alternative routes are selected. The EIS, therefore, addresses road construction, because it can have significant impact on an area. Discussion of access roads can also apply to any road associated with the pipeline, including traffic lanes along the right-of-way.

THE NEED FOR PUBLIC RESPONSE

Following a period of public comment on this draft EIS, DNRC will prepare a final EIS that will recommend to NTPC and the permitting agencies which route seems most practical, economical, and harmonious with Montana's natural and cultural environments. It will also recommend mitigation which may be used as permit conditions. Mitigation for a particular concern may conflict with measures pertaining to different concerns. For instance, mitigation for minimizing impact on visual quality may conflict with measures suggested for aquatic life and habitats. Identifying the measures that would provide the most effective mitigation of the project's overall impacts would require examination of all the possible measures for all concerns and assessment of the tradeoffs. Public input on necessary tradeoffs is important.

TABLE 1. RESPONSIBILITIES OF STATE AGENCIES REGARDING CRUDE-OIL PIPELINE LOCATION AND CONSTRUCTION, AND PERMITS REQUIRED FOR SITING AND CONSTRUCTION

ACTIVITY REQUIRING ACTION	FORM OF ACTION	TITLE OF ACT PROVIDING AUTHORITY	LEGAL REFERENCE[1]	REMARKS
DEPARTMENT OF HIGHWAYS				
Construction along and crossing highway rights-of-way	Encroachment Permit		MCA 69-13-103; ARM 18-2.6 AI (2)-S6010 states provisions	Regulates the location of a crossing
Crossing highway right-of-way	Permit		MCA 7-14-2139, 2140	Permits construction of a ditch across a road, issued by whomever has jurisdiction over the road
DEPARTMENT OF STATE LANDS				
Crossing state land	Easement		MCA 77-2-102, 103	
	Easement	Montana Antiquities Act	MCA 22-3-401, et seq	Granting of easement may depend on a survey of cultural resources
DEPARTMENT OF NATURAL RESOURCES AND CONSERVATION				
Crossing state forest land	Easement		MCA 77-5-103	Forestry Division administers state forest lands. Board of Land Commissioners determines if easements are granted
Hydrostatic testing	Water Use Permit		MCA 85-2-201	Any appropriation of water requires water use permits
Forest slash burning	Permit		MCA 76-13-121	Granted by the Forestry Division
DEPARTMENT OF HEALTH AND ENVIRONMENTAL SCIENCES				
Construction affecting air quality	Permit	Montana Clean Air Act	MCA 75-2-203	For petroleum storage and air-borne particulates from road construction dust
			MCA 75-2-211	Open burning
Construction affecting water quality	Permit	Montana Pollution Discharge Elimination System	MCA 75-5-101, et seq	For discharging hydrostatic test water
		Montana Water Pollution Act	MCA 75-5-201, et seq	Allows short-term activities which will create turbidity in excess of water quality criteria
Crossing designated floodplains	Permit	Floodway Management Act	MCA 76-5-101, et seq	If local governing body has not adopted regulations the department issues and enforces permits
Protection of lake areas	Permit		MCA 75-7-209	If the local governing body has not adopted regulations for lake areas, the department may, upon petition, adopt and enforce regulations until the governing body has adopted its own
DEPARTMENT OF FISH, WILDLIFE, AND PARKS				
Crossing of land owned or leased by the department	Easement		MCA 87-1-301	Easement granted by department commission
Stream crossing	Recommendation	Natural Streambed and Land Preservation Act	MCA 75-7-101	Can require on-site inspection. Acts in advisory capacity to local conservation districts

[1]MCA stands for Montana Codes Annotated. A reference such as MCA 75-7-101 indicates Title 75, Chapter 7, Section 101 of the codes. ARM stands for Administrative Rules of Montana

THE NORTHERN TIER REPORTS

DNRC has issued six reports in conjunction with the draft EIS. The reports document findings presented in the EIS and provide supplemental information on the impacts of construction and operation of a large-diameter pipeline. The reports also add to the limited existing literature on pipeline impacts and consolidate the information gathered for this project so the state and public may have it for future reference. The reports are:

Northern Tier Report 1
The Effects of Large, Underground Pipelines on Soils and Vegetation, with emphasis on the Proposed Northern Tier Pipeline in Montana

Northern Tier Report 2
The Effects of Large, Underground Pipelines on Wildlife, with emphasis on the Proposed Northern Tier Pipeline in Montana

Northern Tier Report 3
The Effects of Large, Underground Pipelines on Aquatic Life and Habitats, with emphasis on the Proposed Northern Tier Pipeline in Montana

Northern Tier Report 4
Earthquake Hazard to the Proposed Northern Tier Pipeline in Montana

Northern Tier Report 5
The Effects of Large, Underground Pipelines on Land Use, with emphasis on the Proposed Northern Tier Pipeline in Montana

Northern Tier Report 6
Social and Economic Impacts of the Proposed Northern Tier Pipeline in Montana

The reports are available on request from:
Montana Department of Natural Resources and Conservation
Energy Division
32 South Ewing
Helena, MT 59601
(406) 449-3780

CHAPTER TWO

DESCRIPTION, PURPOSE, AND JUSTIFICATION OF THE PROJECT AS PROPOSED BY NTPC

NTPC is a Montana corporation, formed in November 1975. It is comprised of the following companies:

1) Butler Associates, Inc., Tulsa, Oklahoma
2) Curran Oil Company, Great Falls, Montana
3) Farmers Union Central Exchange, Inc. (CENEX), St. Paul, Minnesota
4) Glacier Park Company, a subsidiary of Burlington Northern, Inc., St. Paul, Minnesota
5) MAPCO, Inc., Tulsa, Oklahoma
6) MNT, Inc., a wholly owned subsidiary of Milwaukee Land Company, a subsidiary of Chicago, Milwaukee, St. Paul, and Pacific Railroad Company, Chicago, Illinois
7) U.S. Steel Pipeline Co., Inc., a wholly owned subsidiary of United States Steel Corporation, Pittsburgh, Pennsylvania
8) Western Crude Oil, Inc., Denver, Colorado
9) Westinghouse Pipeline Company, a subsidiary of Westinghouse Electric Corporation, Pittsburgh, Pennsylvania

This chapter describes the Northern Tier pipeline system as proposed by NTPC. Chapter five includes an evaluation of NTPC's design criteria and construction methods.

PURPOSE AND JUSTIFICATION

Oil has become the predominant source of energy in the United States over the last twenty-five years. In 1976, petroleum made up 46 percent of the U.S. energy supply (USDOE 1977). During this time, domestic production has declined causing imports to steadily increase. According to a study done by the Pace Company (1978), an independent consulting firm retained by NTPC, petroleum will continue to make up approximately 47 percent of the total U.S. energy consumption through the year 2000.

Canadian oil exports, which constituted approximately 51 percent of all U.S. imports in 1970, began declining after 1974. Because of decreasing energy reserves, present Canadian government policy allows for discontinuance of crude oil exports to the U.S. by 1982. This would have a major impact on the Northern Tier states, which are the primary market for the Canadian crude. (As defined by the 1976 Alaskan Natural Gas Transportation Act, the Northern Tier states are Washington, Oregon, Idaho, Montana, North Dakota, Minnesota, Michigan, Wisconsin, Illinois, Indiana, and Ohio.)

With the development of the Trans-Alaska Pipeline System (TAPS), the supply of crude oil on the West Coast exceeds area-refinery demand. Currently, the Alaskan system produces approximately 80,000 m³/d (500,000 bpd) in excess of West Coast capacity. This is expected to increase. The excess is now being transported down the coast and through the Panama Canal to the mid-continent pipeline system. NTPC proposes a common carrier pipeline, designed to receive and transport both domestic and foreign crude oil, as a method for moving the surplus oil to inland markets. The system would be capable of transporting 113,000 m³/d (709,000 bpd) initially and an anticipated 150,000 m³/d (933,000 bpd) within five years of beginning operation. NTPC projects that approximately 50 percent of the initial throughput would be Alaskan North Slope crude, with the remainder coming from other domestic and foreign sources (USDI 1979).

PROJECT COST ESTIMATE

NTPC's project cost estimates for an initial system capacity of 113,000 m³/d (709,000 bpd) are $399,728,000 for construction in Montana and $1,152,131,000 for total system construction. These estimates include contingencies, taxes, environmental studies, permit acquisition, engineering, and construction management; it excludes escalation, interest during construction, cost of the 2,100,000 m³ (12,629,000 barrels) of line fill, working capital, and debt expense.

PIPELINE DESIGN AND CONSTRUCTION

System Design

NTPC's proposed pipeline originates at Port Angeles, Washington, where NTPC would construct a marine terminal consisting of tanker unloading facilities and two submarine pipelines connected to onshore storage facilities northeast of the port at Green Point, Washington. The terminal would be designed for tankers ranging in size from 18,000 deadweight tons (dwt) to 300,000 dwt at unloading rates up to 16,000 m³ (100,000 barrels) per hour.

The approximately 2,399-km (1,491-mi) oil transportation system would cross Washington, Idaho, Montana, and North Dakota, terminating at Clearbrook, Minnesota. The pipeline would cross approximately 1,014 km (630 mi) of land in Montana. NTPC's route crossing Montana is shown on map 1, p. 12.

The pipe would be manufactured, tested, and inspected to meet all the requirements of the latest American Petroleum Institute specifications. In addition, NTPC has pro-

posed to impose more stringent specifications in certain areas such as fracture toughness. There would normally be approximately 91 cm (36 in) of land cover over the pipe. To prevent corrosion of the pipe from pipe-soil contact, an external coating system would be applied.

NTPC would install mainline valves at selected points along the line to reduce line drainage in case of a leak or accidental rupture. Both block and check valves would be installed. Check valves, which permit flow in only one direction, would be located at the base or along uphill sections of the pipeline and would automatically prevent backflow if the line were temporarily shut down. The remotely operated block valves could be locally operated when necessary.

Right-of-way

NTPC proposes a temporary 27-m (90-ft) construction right-of-way. For a permanent right-of-way, NTPC proposes 23 m (75 ft) for state and private land and 16 m (54 ft) for federal land. The latter conforms to federal law. NTPC may request additional width temporarily during construction in areas with special construction conditions.

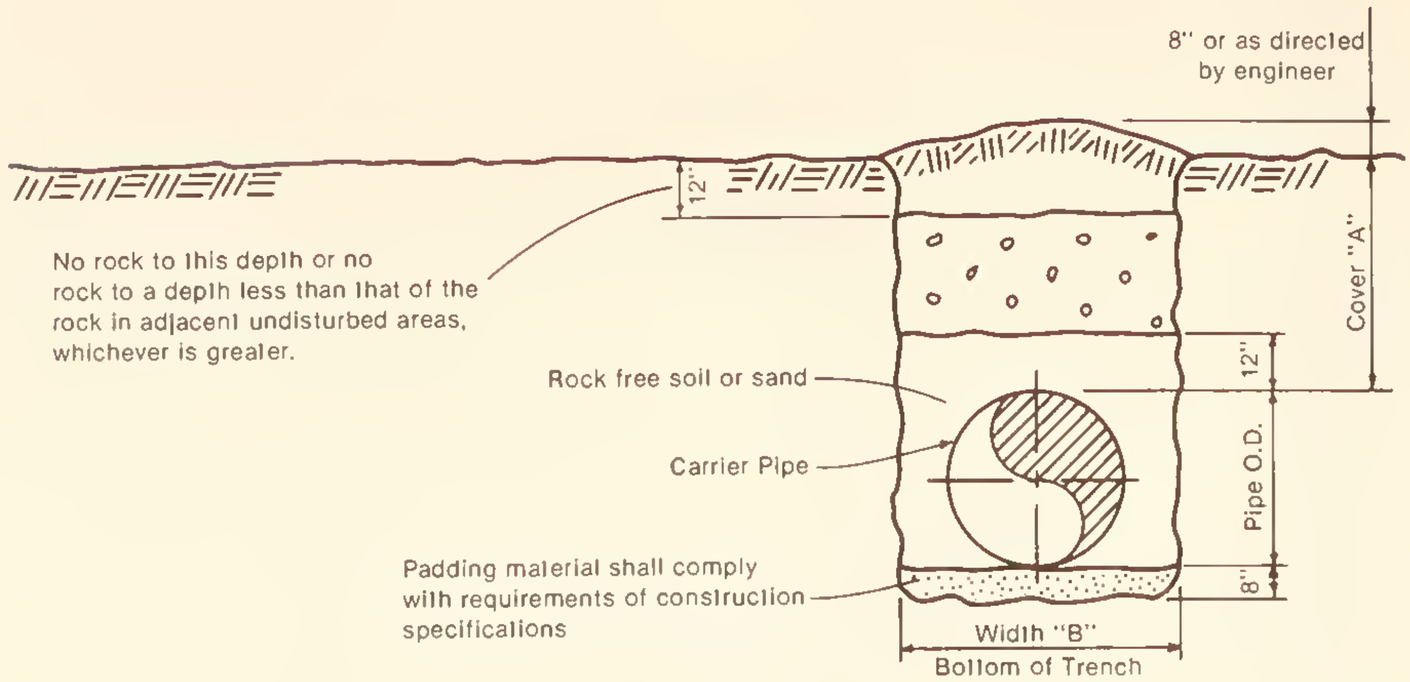
Line Construction

The pipeline system construction from Green Point to Clearbrook would be divided into ten construction sections. Construction sections 4, 5, 6, 7, and 8 of NTPC's proposed route would cross Montana. These are described in table 2.

Construction of each of the pipeline sections would begin simultaneously at their western ends and proceed eastward. Construction of the pump stations and delivery facilities would take place at the same time as the construction of the pipeline sections.

Work on the pipeline sections, the pump stations, and the delivery facilities is proposed to begin in March 1980. Construction would proceed continuously, with the pipeline completed by the end of 1980 and the pump stations and delivery facilities completed by May 1981. This schedule assumes neither delays in startup nor delays due to inclement weather nor the

FIGURE 1. TYPICAL PIPELINE TRENCH AND BACKFILL REQUIREMENTS



REQUIRED DIMENSIONS (INCHES) FOR PIPE INSTALLATION[1]

NOMINAL PIPE SIZE (INCHES)	RESIDENTIAL COMMERCIAL & INDUSTRIAL AREAS			CROSSINGS OF WATER COURSES			DRAINAGE DITCHES AT RAILROADS & PUBLIC ROADS			ALL OTHER AREAS		
	Cover "A"			Cover "A"			Cover "A"			Cover "A" [2]		
	Norm Excav	Rock	Width "B"	Norm Excav	Rock	Width "B"	Norm Excav	Rock	Width "B"	Norm Excav	Rock	Width "B"
40	36	30	62	48	18	76	36	36	62	36	18	62
42	36	30	64	48	18	78	36	36	64	36	18	64

Source NTPC 1978
Conversions. 1 in = 2.54 cm
[1] These are minimum specifications and may be increased by special requirements.
[2] Cover may be greater in areas where deep cultivation occurs or is likely to occur. Additional cover may be required in rock areas

necessity for construction to continue during mid-winter months. Any of these factors would result in construction being completed at a later date.

The length of the construction spreads, which are the areas actually being worked on at any one point in time, would vary from 13 to 26 km (8 to 16 mi). The rate of construction progress would also vary from 3.9 km (2.4 mi) per week on the more difficult terrain in western Montana to 8.7 km (5.4 mi) per week in open country.

Before construction, centerline evaluation and refinements would be necessary. A location survey, determining the precise location of the proposed pipeline on the ground, would be followed by construction staking, which determines the locations of cleared rights-of-way, staging areas, passing lanes, and other necessary support facilities. Survey crews would use existing access roads where possible and usually travel to remote roadless areas on foot.

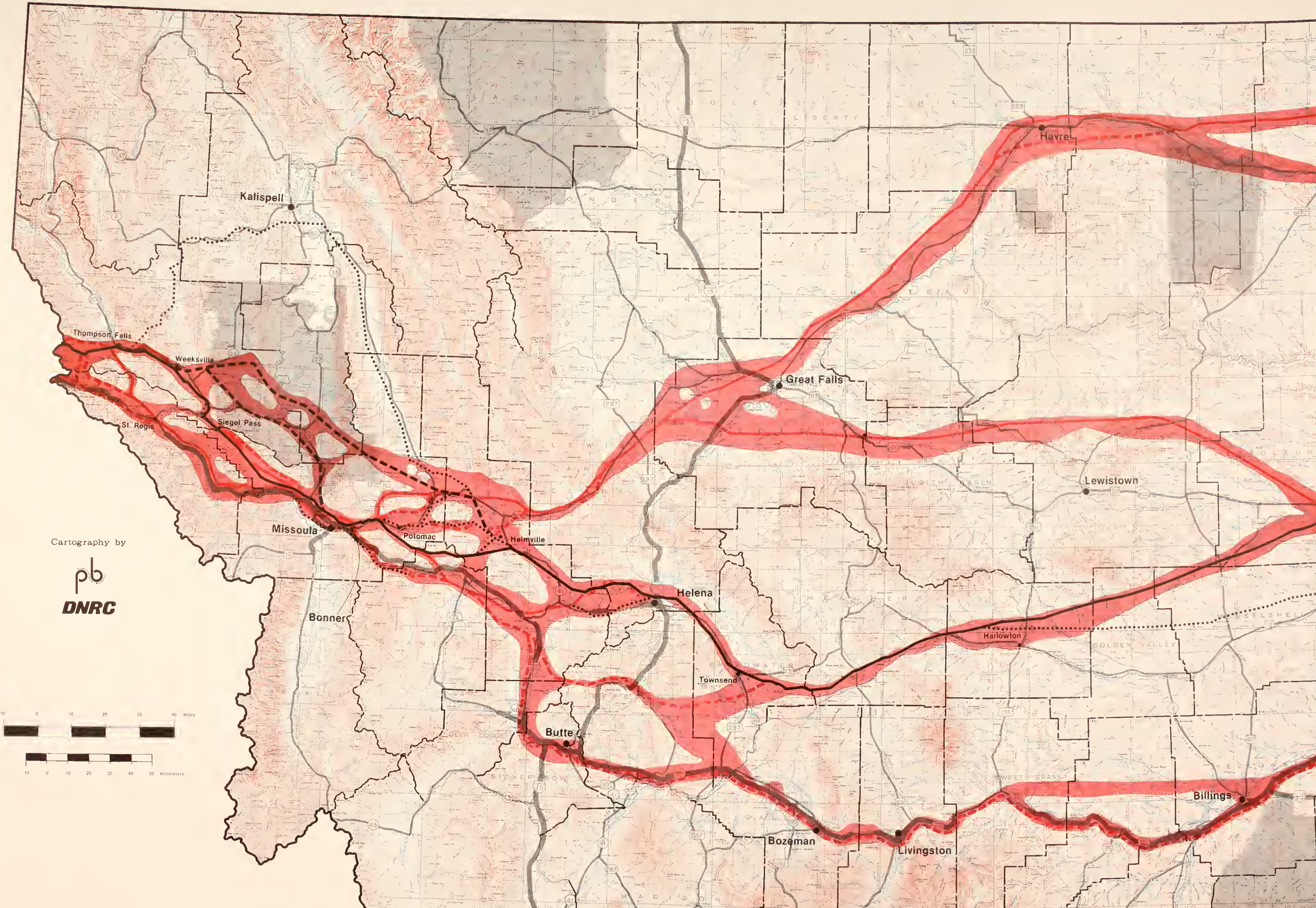
After surveying, the area would be cleared and graded. Clearing includes removal of obstacles such as trees, brush, crops, and boulders. Any large trees would be cut into manageable and marketable lengths and removed from the right-of-way. The ground surface would then be graded as needed to permit placement of the pipeline at the desired elevation.

Trenching would include all excavation work necessary to provide a trench of the specified dimensions and depth for required pipe cover. The trench would be 1.5 to 1.8 m (5 to 6 ft) wide, 2.1 to 2.4 m (7 to 8 ft) deep, and open in lengths of 6.4 to 12.8 km (4 to 8 mi) at a time. In extremely rocky terrain, it may be necessay to blast rock into manageable size. Trenching may also be accomplished with backhoes, power shovels, draglines, hand tools, plows, or rippers. A list of the equipment NTPC proposes to use for a typical construction spread is given in appendix A. Figure 1 shows a typical pipeline trench cross-section.

NTPC has estimated that forty pipe-storage yards averaging 5 ha (12 acres) per yard would be necessary for the entire line. Sites

TABLE 2. CONSTRUCTION SECTIONS ON NTPC's PROPOSED ROUTE CROSSING MONTANA

SPREAD NO.	DESCRIPTION
4	From a point in eastern Washington to approximately 11 km (7 mi) east of Thompson Falls
5	From roughly 11 km (7 mi) east of Thompson Falls to a point just west of Potomac
6	From just west of Potomac to a point approximately 19 km (11 mi) north of Townsend
7	From north of Townsend to a point about 8 km (5 mi) west of Mosby
8	From west of Mosby to the North Dakota border


Havre
Kalispell
Great Falls
Thompson Falls
Weeksville
Siegel Pass
St. Regis
Lewistown
Missoula
Potomac
Helmville
Helena
Bonner
Harlowton
Townsend
Butte
Billings
Bozeman
Livingston
Cartography by
pb
DNRC
Miles
Kilometers

would be used from two to sixteen months, depending on location and construction progress. Pipe-stringing trucks would be used to transport the pipe in 12 or 24 m (40 or 80 ft) lengths from the storage yards to the pipeline right-of-way, where sideboom tractors would lay the pipe joints beside the trench for lineup and welding. The pipe would be bent as required both vertically and horizontally to conform to the terrain and the trench bottom would be graded so that the pipe would contact the trench bottom throughout its length.

After the pipe is lowered into the trench, the trench would be backfilled. Motor graders, angle dozers, crawler-mounted side-pull backfillers, and auger backfillers would be used to move dirt from the spoil bank to the ditch. In certain areas, where damage may occur to the pipe coating or tape, additional protection would be provided by padding the trench with select backfill material.

The cleanup operation would consist of the removal and disposal of all surplus materials and construction debris, as well as restoration of the normal contour of the surface soil. Markers showing exact locations of the pipeline would be installed at road, railroad, and fence crossings. They would identify the owner of the pipeline, material transported, and location and telephone number for contact in case of emergency.

NTPC's reclamation plan is summarized in chapter three, p. 16.

Crossings

Waterway Crossings

NTPC proposes to trench all waterway crossings. However, there are other crossing methods now being considered. These are discussed in chapter five, p. 40.

Temporary land use would be necessary for staging areas at trenched river crossings. Staging areas would average 46 by 61 m (150 by 200 ft), and would be used from a few days to three months.

USDOT regulations require the cover over the pipeline to be a minimum of 122 cm (48 in) below scour depth at waterway crossings; if rock excavation is encountered, the cover my be reduced to 46 cm (18 in). USDOT also requires that valves be installed at the high-water mark on each side of water crossings over 30 m (100 ft) wide.

NTPC plans to increase the wall thickness of the pipe and to increase the thickness of the corrosion-preventing coating at all major crossings. Either a continuous concrete coating or individual concrete weights would be applied to provide the negative buoyancy needed to keep the pipeline buried beneath the streambed.

Highway and Railroad Crossings

Major highways and railroads are normally drilled and cased within a steel pipe. Crossings of secondary roads and other hard-surfaced roads are commonly done without casing. Where roads are unimproved or where drilling is impractical, the crossing may be trenched. This can be done by opening only half of the road at a time, thus minimizing traffic problems. This method allows installation of the pipeline with or without casing.

Crossing Private Property

NTPC would purchase land for pump stations and delivery facilities. For the pipeline, easements would be negotiated with property owners. Under these agreements, NTPC would compensate the property owners for the easement and any damages occurring during construction. Payment would also be made to the landowner for any damage that may occur during maintenance of the pipeline. NTPC has filed with the Montana Public Service Commission its acceptance of the provisions of Section 69-13-101, MCA, and statutorily has the powers of eminent domain. This gives the company the right to condemn private land if necessary.

Hydrostatic Testing

USDOT regulations require a hydrostatic test to be performed after construction and before operation. The test procedures cannot be prepared until the exact profile of the pipe is known (see appendix B). The hydrostatic test would consist of pressurizing the pipeline with water to at least 1.25 times the internal design pressure and holding that pressure for twenty-four hours. During the test period, line pressures and temperatures would be continuously recorded and monitored. Any leaks would be repaired and a new hydrostatic test initiated. All portions of the pipeline must be successfully tested before the system could become operational.

Personnel Requirements

Construction on NTPC's proposed route in Montana would require an estimated 16,735 person-months of labor. During the three peak labor months—May-June-July 1980—of the present construction schedule, there would be over 2,000 persons employed on the project in the state. Peak labor requirements of approximately 423 to 463 persons (including the cleaning and grading crews) are anticipated over a six-month period in each pipeline construction section.

A total of 236.5 person-months are estimated to be necessary for construction of each pump station—an average of nearly twenty-four persons per month over the ten-month construction period. The actual staffing pattern may vary substantially, depending on the contractor executing the work.

ASSOCIATED FACILITIES

Pump Stations

Pump stations would be located along the route to maintain the desired throughput by boosting the pressure in the pipeline to overcome elevation differences and the friction loss caused by the oil flow. Eighteen pump stations and one pressure-reducing station would be needed for the initial throughput of 113,000 m^3/d (709,000 bpd); three more pump stations, one of which would be a converted surge relief tank installation, would be necessary for the ultimately proposed throughput of 150,000 m^3/d (933,000 bpd).

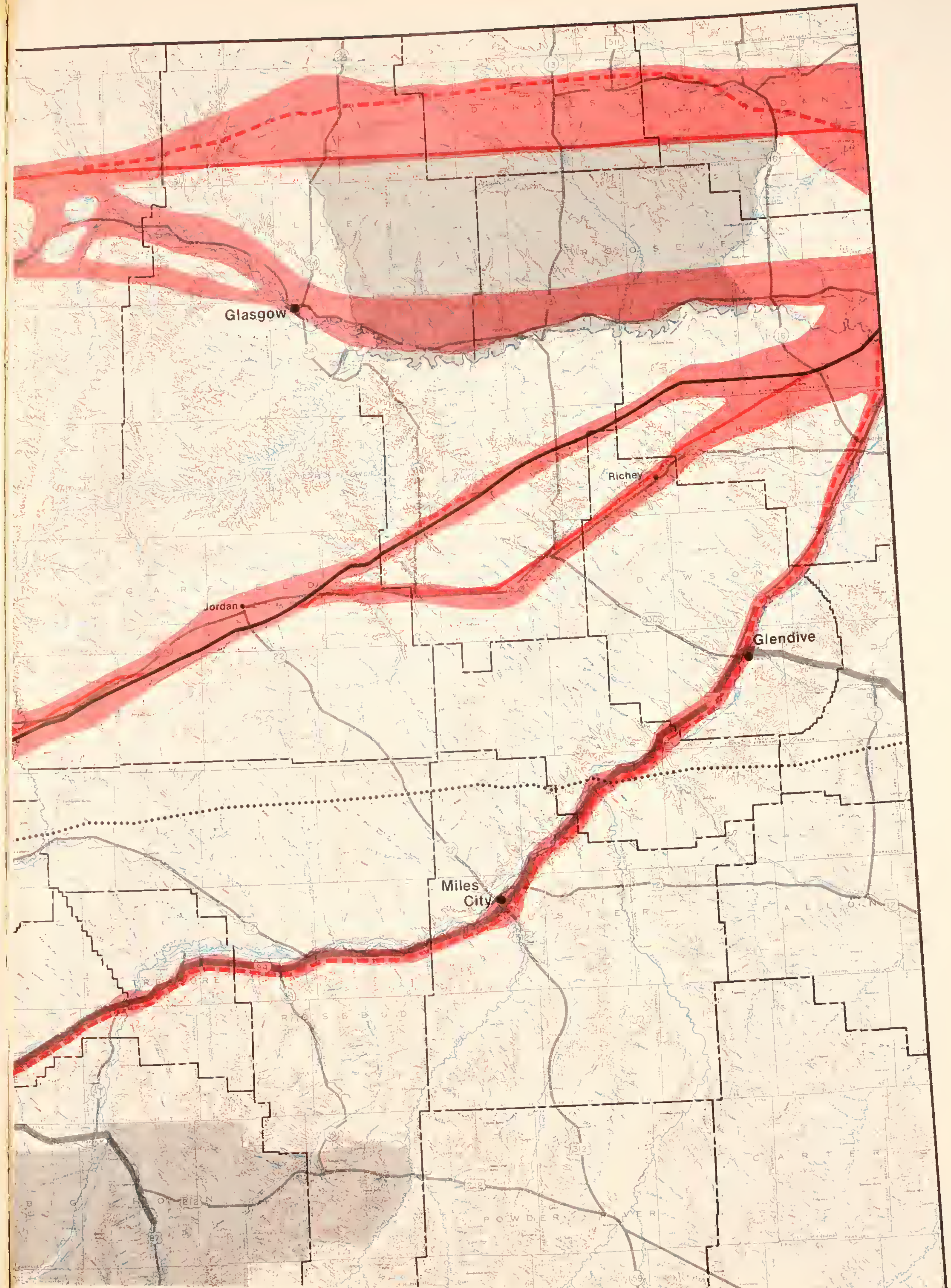
Seven of these pump stations would be located in Montana in the following general areas: Paradise, Potomac, Helmville, Townsend, Harlowton, Jordan, and northeast of Richey. Each would require approximately 2 ha (5 acres) of permanent land use. Driveways to the pump units would also be permanent. Major equipment and support facilities at each pump station would include the electrically driven centrifugal pump units, surge relief tank (if required), launchers and receivers for pipeline cleaning equipment (if required), strainers, drain system, pressure-control valves, piping, control building, high-voltage supply, transformers, walk-in switchgear, communications tower, access roads, lighting, emergency diesel generator, and fencing. Permanent helicopter pads would be located at the pump station, allowing quick access at all times. USDOT regulations require that mainline valves be installed on both sides of pump stations permitting isolation of the station if necessary.

NTPC proposes to install at each station an emergency diesel-fueled generator which could automatically provide sufficient power for emergency lighting, the supervisory control system, and valve operation. The control building at each pump station would house the supervisory control equipment required to monitor the pumping units, valve positions, flow rate, station pressure, and temperature conditions. The control building would also house the communications equipment.

Electrical power would have to be supplied by the utility companies or rural electric cooperatives serving the area.

A surge relief tank would be located at selected stations. The need would be based on terrain profile upstream and downstream of the station and upon system-operating factors. If the pressure on the incoming line should exceed a predetermined pressure setting, the surge relief valve would automatically open into the surge relief tank. The pipeline dispatcher at the main control center would immediately receive an alarm with a readout of the level of oil in the tank, and appropriate corrective action could be taken. When normal operation

MAP NO. ONE



MAP NO. ONE

ROUTE IDENTIFICATION

NORTHERN TIER ROUTES

- Northern Tier's Proposed Route (NTPR)
- Northern Tier's Proposed Alternatives
- Alternatives no longer being considered

DNRC ROUTES

- DNRC Proposed Alternatives
- Alternatives no longer being considered

Indian Reservations

Corridor
A linear study area .5 km (0.3 miles) to 20 km (12.4 miles) in width, within which a pipeline route could conceivably be located.

ROUTE IDENTIFICATION

could be resumed, a pump would reinject the oil from the tank back into the pipeline.

Delivery Facilities

The delivery facilities at Clearbrook would provide crude oil to a major pipeline network transporting oil to refineries in midwestern and eastern states. NTPC also proposes to construct delivery facilities in North Dakota, as well as at two sites in Montana. The proposed pipeline would cross the Glacier Pipeline abut 35 km (22 mi) northeast of Harlowton, Montana. The delivery facilities here would be capable of delivering up to 15,000 m^3/d (95,000 bpd) initially and 18,300 m^3/d (115,000 bpd) ultimately. The proposed pipeline would also cross the Western Crude Oil Pipeline approximately 32 km (20 mi) northeast of Richey, Montana. These facilities would be capable of delivering up to 8,000 m^3/d (50,000 bpd) initially and 10,000 m^3/d (60,000 bpd) ultimately. Preliminary estimates indicate the Glacier facilities would require 24 ha (60 acres), while the Western Crude Oil facilities would require 20 ha (50 acres). This would be a permanent land use and would include oil storage facilities and a pump station at each site.

OPERATION AND MAINTENANCE

The overall operation of the oil transportation system would be controlled and monitored by means of a supervisory control and data acquisition system. This would consist of a master station at the Green Point facilities; a communications system; and remote stations located at the tanker-unloading berths, pump stations, pressure-reducing stations, and delivery facilities along the proposed route. The overall control and monitoring of major elements would be performed by terminal and pipeline dispatchers in the control building at the onshore storage facilities. The line facilities could also be controlled locally if the supervisory or communications link were inoperative.

At each pump station, suction and discharge pressure would be telemetered to the supervisory control computers and would be monitored for deviations and rates of change. Any change which may indicate a pipeline leak or other malfunction of the line would activate an alarm and print out for the pipeline dispatcher. Flow rate would also be monitored at all receiving and delivery points on the pipeline, as well as at selected pump stations. These data would be continuously telemetered to the control computers. Data scan at all remote sites would occur every ten seconds. Errors caused by the communication channel frequency response would normally be corrected in the next scan. Through this system, failures would be immediately indicated by alarms. The dispatchers would then take action to correct the upset condition. If the problem could not be handled remotely from the main control center, the dispatcher would call field personnel. A leak detection system would be a separate function of the supervisory control system.

District pipeline offices in Spokane, Washington; Helena, Montana; and Williston and Grand Forks, North Dakota, would be responsible for maintaining the pipeline and station facilities. Personnel at each district office would handle routine maintenance such as installing and maintaining crossing markers and inspecting pipeline, highway, railroad, and river crossings. Major repair or maintenance would be done by contract. Forty-eight people are projected to be permanently employed by NTPC in Montana.

USDOT requires that surface conditions on and near a pipeline right-of-way be inspected from the air every two weeks for leak detection as well as for spotting other conditions which may affect the line. USDOT also requires inspection of underwater crossings of navigable waterways, at intervals not to exceed five years.

The communications system would link the marine terminal facilities, district offices, and pipeline system with the main control center at the onshore storage facilities. This system would provide communication links to allow administration and operation of the total system-teleprinter, data transmission, and mobile communications. Communications linking the total system would be a combination of land lines and microwave.

For voice communications, a telephone system would link all locations connected by the supervisory control and data acquisition system, as well as pipeline district offices.

ABANDONMENT PROCEDURES

Future situations, such as insufficient crude oil or other economic difficulties, could terminate operation of the proposed pipeline. This would mean abandonment and possible salvaging of all or portions of the line. Abandonment could require draining, disconnecting, dismantling, and disposing the complete system.

Removal of the crude oil from the pipeline could be accomplished by displacing it with water. Selected pumping units would be used to gradually displace the oil and water into delivery facilities. If removal of the water from the system were required, truck transport would be used to deliver the water to oil-water separators. Retention of water in the pipeline system would require addition of a corrosion inhibitor.

Removal and salvage of the pipe and mainline valves would require activities similar to construction of the system, but with a more simplified work scope. Some sections of the pipeline, such as river and road crossings, might not be removed. The ends of the pipeline on both sides of the crossings would be sealed and covered with soil. Additional backfill might be required to restore the right-of-way to its original condition.

Mainline pumps and motors would be disconnected and either stored or removed for other uses. Abandonment procedures for the delivery facilities would begin after the entire system had been completely evacuated of oil. Support facilities would be taken out of service in accordance with standard procedures and safety regulations; moveable items would be sold or salvaged.

MITIGATING MEASURES

NTPC has proposed many mitigating measures which would minimize some of the potential impacts of the proposed project. Some of these are included in the possible mitigating measures listed in chapter six. The final EIS will specify which measures are recommended by the state of Montana.

CHAPTER THREE

APPROACH

In compliance with MEPA, this draft EIS addresses the Montana portion of the proposed pipeline system and alternatives to the proposed action. Several alternative routes were identified to be studied along with NTPC's proposed route. Selection of the study corridors and route identification are described below.

DNRC requested that NTPC prepare and submit for review and approval the following:

1) An oil spill contingency plan for construction and operation
2) Construction guidelines
3) A quality-control plan
4) A reclamation plan

DNRC has received the draft reclamation plan and the draft "Oil Spill Contingency Response Plan" (NTPC 1979a), which are summarized in the chapter. The construction guidelines and quality-control plan cannot be prepared until design plans are more complete.

If the proposed pipeline is constructed, it is in the best interest of the state that it be built in the most socially and environmentally acceptable manner. Therefore, DNRC has proposed that NTPC and DNRC enter into contractual agreements to have qualified state representatives participate in centerline selection and in construction surveillance. Alternatives for state surveillance are given in this chapter, while DNRC's proposal for centerline evaluation is included in appendix C.

STUDY AREA SELECTION

Many environmental and sociological concerns were considered in the pipeline corridor selection studies. These concerns are listed in table 3, p. 16. After NTPC's proposed and alternative routes were mapped, corridors which merited consideration were identified. Where possible, areas such as large lakes and reservoirs, wilderness, and major mountain masses over 2,100-m (7,000-ft) high were avoided. Areas subject to legal constraints (such as RARE II areas) were also avoided where possible.

A special effort was made to identify corridors which would avoid Missouri River crossings by staying north of that river. Corridors were chosen in which route and centerline location could reduce the number of river and stream crossings. Interstate and other highway corridors were used when feasible, and an effort was made to stay within 4.8 km (3 mi) of existing paved roads to avoid disturbance of wildlife. The corridors chosen generally followed river valleys and existing transportation or utility corridors, especially in eastern Montana where terrain usually would not be a constraint. Although the criteria used in transmission-line corridor selection often greatly differ from those used in pipeline route selection, DNRC also considered corridors identified by DNRC and the Bonneville Power Administration for the Colstrip-Hot Springs twin 500-kV line. (A corridor for the Colstrip-Hot Springs line was selected by federal agencies on Sept. 21, 1979; it will be discussed in more detail in the final.)

Corridor width varied. It was narrow, for instance, where constrained on both sides by serious concerns, such as rugged topography or legal restrictions, and wide where not tightly constrained. In general, the corridors were narrower in the mountains of western Montana than on the eastern Montana plains.

After the preliminary corridors were identified (shown on map 1, p. 12), they were charted on two- and three-dimensional relief maps (scale, 1:250,000); the areas on or next to the proposed corridors were then examined in detail. Wildlife refuges, RARE II areas, BLM wilderness study areas, and lakes greater than 1.6 km (1 mi) in diameter were also plotted on the two-dimensional maps.

A variety of resource maps were used to refine boundaries of the preliminary corridors and determine the actual study corridors. Critical sites less than 64 ha (160 acres), such as state parks or small towns, usually were not given consideration; the corridors were wide enough to allow avoidance of such sites by judicious route and centerline location.

Although RARE II areas may not ultimately be designated as wilderness or otherwise protected from development, there were, where possible, excluded from the study corridors. Because these areas generally have high aesthetic, recreational, and wildlife value, besides their present and future value as wilderness areas, avoidance was preferred.

Mountain slopes and ridges were excluded from all corridors in eastern Montana where ample opportunity exists for siting in more suitable areas. In western Montana, however, only the steepest and highest mountains were excluded; there, the extent of valley bottoms and other flat areas is limited.

After the corridor boundaries had been plotted, they were examined by DNRC and by the Montana Department of Fish, Wildlife and Parks (DFWP). Several conservation districts and planning offices also submitted comments. The study boundaries were further modified and certain corridors which showed either major disadvantages or no clear advantages were eliminated. The remaining study corridors were drafted onto

base maps (scale 1:125,000). All corridors west of Helena and certain critical or congested areas east of Heléna were also drafted onto topographical maps.

After the study corridors were identified, detailed study of the environmental concerns began. Field work was kept to a minimum because much of the study was done during the winter months of 1978 and 1979 and because the routes being considered have a combined length of approximately 2,400 to 3,200 km (1,500 to 2,000 mi)—a length too great to uniformly study within the time frame of this EIS. Therefore, available information was used when possible.

The study focused on feasible routes within the corridors as they were identified. Along the routes, the study concentrated on areas which had high potential impact risk, such as sensitive stream crossings.

Resource inventory and risk analyses were not attempted for all environmental concerns or for the entire area within each corridor. Instead, only data relevant to identification of feasible routes were gathered. A large data base of general resource inventories was already available. This included information on legal constraints, slope, elevation gains and local relief, effects on water quality, existing powerlines and pipelines, general geology, land use, visual sites, human settlements, and climate.

New information was primarily needed for (1) effects on aquatic life at and below stream crossings; (2) possibly active fault zone and sites of mass-failure risk; (3) locations of erodible and infertile soils where soil surveys were not available; (4) compatibility of the pipeline with existing transportation corridors such as highway, railway, utility, and other pipeline systems; and (5) risk of flood damage and construction difficulties at stream crossings.

When possible, the study used data gathered from the federal environmental impact statement on the proposed pipeline (USDI 1979). DNRC also made use of U.S. Forest Service (USFS) studies of the pipeline route in Montana, which were done for the federal EIS (USDA 1978). Duplication of engineering and geotechnical work planned by NTPC was avoided where possible; however, some redundancy was desirable for certain aspects of the study, especially evaluation of high-risk sites (such as river crossings).

After the inventory data were gathered, they were plotted on clear acetate overlays for the 1:125,000 base maps, which are on file and can be examined at DNRC.

After NTPC's proposed route was plotted on the base maps, alternative routes were plotted in accordance with engineering and environmental concerns. The routes were reviewed by state agencies, refined, and redrafted for tabulation. Many minor alternative segments, each a few kilometers in length, were retained if a decision to delete could not be made based on available data. Since some of these segments fell outside the original study corridors, additional inventory data had to be mapped. That done, impact data, such as length of cropland crossed or number of river crossings, were tabulated for each of the alternative route segments. Tables 42 and 43 in chapter seven, pp. 96 and 98, summarize the tabulations.

Over one hundred route segments were identified and tabulated; thus, there are numerous ways these segments could be combined into a single route across Montana. The original data for all segments are on file at DNRC and are available for public inspection. To simplify presentation of data and comparison of the routes, only NTPC's proposed route and the alternatives identified by DNRC as most reasonable are evaluated in chapter seven. With the exception of NTPC's St. Ignatius Route, all of these alignments pass through a common point 8 km (5 mi) east of Missoula near Bonner. They will be discussed in three groups: four major routes from the Idaho border to Bonner, four major routes from Bonner to the North Dakota border, and the St. Ignatius Route, for a total of seventeen possible routes across Montana. The routes are shown on map 2, p. 18.

CENTERLINE SELECTION

Centerline selection would begin after a pipeline route is chosen. DNRC has proposed to NTPC that a state team work with company personnel in identifying a centerline, preparing supportive information to aid the permit and easement process, preparing site-specific mitigation recommendations, identifying locations needing state surveillance, determining frequency of inspection during construction and reclamation, and determining necessary expertise of inspectors. The proposed centerline study and NTPC's response are included in appendix C. Public comment is needed on this proposal.

NTPC'S RECLAMATION PLAN

On May 18, 1979, NTPC provided DNRC with its reclamation and revegetation plan for Montana. The short-term objectives of this plan are seedling establishment and soil stabilization on the right-of-way immediately after line construction, while

TABLE 3. PIPELINE SITING CONCERNS

	Used in corridor selection	Used in route selection/evaluation	To be used in centerline selection	Report Number	Discussion page number	Route comparison page numbers	Map numbers
Engineering and Geotechnical Concerns (Affecting pipe integrity and construction costs)							
Terrain, Engineering, and Hydrologic Constraints	X	X	X	—	—	102	4
Earthquake Hazards	X	X	X	4	42	102	3
Geologic Concerns and Mineral Resources	X	X	X	—	53	102	4
Electrical Service	X	—	—	—	54	103	—
Environmental Concerns (Dealing with pipeline impacts on the environment)							
Land Use[1]	X	X	X	5	55	103	5
Social and Economic Concerns	X	—	—	6	57	103	—
Cultural Resources	X	X	X	—	63	104	—
Visual Quality	X	X	X	—	64	104	5
Soils	X	X	X	1	65	104	4
Aquatic Life and Habitats	X	X	X	3	68	104	6
Ground Water	X	X	X	—	76	105	4
Vegetation and Land Productivity	X	X	X	1	78	105	7
Wildlife and Habitats	X	X	X	2	85	106	8
Climate and Air Quality	—	X	—	—	92	106	—

[1]Including legal constraints, specially managed areas, compatibility with existing corridors, site and linear patterns

long-term objectives relate to the perpetuation on the right-of-way of plant communities that are compatible with postconstruction land use and with pipeline surveillance and maintenance. This plan contains an analysis of revegetation constraints (such as soil characteristics, precipitation, weed infestations) found in the counties crossed by NTPC's proposed route, and present guidelines for revegetation of these areas. According to these guidelines, the field inspection of soils along the centerline would be made after centerline selection, while the line is being surveyed. This soils survey would determine optimum depth of topsoil excavation, site conditions determining optimum seed mixtures, and areas requiring special techniques (such as areas with shallow soils; steep slopes; saline, alkaline, or acid soils; and riparian influence).

For most of the right-of-way, revegetation would be accomplished by plowing and disking the soil, drilling with specified grass seed mixtures, and fertilizing and mulching where necessary. Immediate soil stabilization in certain situations would be accomplished by sowing temporary cover crops such as wheat, rye, or barley. Specific seed mixtures and planting dates for different situations found along NTPC's proposed route, as well as special techniques for revegetation of sensitive areas or problem areas, are proposed. On private land, especially cropland, landowner preferences would be given first priority in determining revegetation goals and methods. Long-term monitoring of reclamation is also proposed. NTPC's target of right-of-way reclamation success over time is defined in terms of the percentage of canopy coverage of perennial species found on adjacent rangeland, as follows: 30 percent after one year, 50 percent after five years, and 90 percent after ten to fifteen years in the lowest annual precipitation zones. Techniques are outlined for both mechanical and chemical weed control on the right-of-way, protection of newly-seeded areas, and long-term management of the right-of-way to control regrowth of woody vegetation.

NPTC'S OIL SPILL CONTINGENCY RESPONSE PLAN

NTPC's "Oil Spill Contingency Response Plan" consists of two parts: "General Provisions" and the "District Plans." NTPC has submitted a draft copy of the "General Provisions" to DNRC for review; the more detailed "District Plans" will not be completed until a centerline is selected and the final pipeline design is complete.

General policy and the organizational structure of the "Oil Spill Contingency Response Plan" are described in the "General Provisions." The first part of the plan also describes the oil spill task force—personnel responsible for supervision, coordination, field team operation, and advising during an oil spill. The "General Provisions" also details action necessary for leak detection, leak control, spill containment, cleanup, wildlife care, pipeline repair, waste disposal, and restoration. There are special sections on environmental guidelines for access and protection of soils, regulatory agencies and regulations, use of contractors, communications, oil-soaked bird rehabilitation, block and check valve locations, characteristics of spilled oil, and the organization and scope of the district plans.

Five district plans are proposed, each based on the location of one of the permanent district offices along the pipeline route. Each district would be divided into contingency areas based on similar physical characteristics. In the event of an oil spill, NTPC's response would be coordinated at NTPC headquarters. The actual containment and cleanup operation would be done by the appropriate district and according to site-specific plans and field characteristics of the contingency area. A district plan would contain names and phone numbers of all persons and agencies concerned, general operating procedures and organization, site-specific response procedures, instructions for waste disposal and restoration, and training programs. The site-specific response procedures and actions would be the core of each district plan. They would include air photos showing the pipeline route, valve locations, related facilities, critical access points, drainages, and problem areas.

ALTERNATIVES FOR STATE SURVEILLANCE OF CONSTRUCTION

Surveillance of easements, conditions, and construction would be an important way to prevent or reduce adverse impacts that could result from construction of the proposed pipeline. The federal government is responsible for surveillance of pipeline easements across federal land to ensure that easement conditions are met. It also monitors pipeline construction on lands of all ownerships to ensure that USDOT construction standards are met. Besides the federal inspectors, NTPC proposes to have its own construction monitors. Adverse impacts could be further mitigated by state surveillance to ensure compliance with permit conditions. Four alternative surveillance programs, each with varying degrees of state involvement, have been developed.

DNRC will recommend a surveillance proposal in the final EIS. Public comment on the alternatives presented here is important to determine which alternative or combination should be adopted.

Surveillance alternatives A and B each propose to establish a State Pipeline Coordinator's Office (SPCO). Because MEPA does not provide funding for surveillance, a contractual agreement would have to be made with NTPC which would cover all SPCO expenses.

The primary purpose of SPCO would be to provide continuous government surveillance to guarantee compliance with permit conditions. Other objectives would be (1) coordination of state permitting agencies; (2) close coordination of federal, state, and company monitors; (3) enforcement of an oil spill contingency plan; (4) enforcement of a reclamation plan; and (5) administration and enforcement of a quality-control program during the construction phase, including cleanup and reclamation.

DNRC would employ a coordinator to act as a liaison between SPCO and the Department. Prior to construction, SPCO would have only a skeleton staff. This would increase as the actual construction period neared, with all staff hired in time to be properly trained. SPCO staff would gradually be phased down during reclamation. After the pipeline is operational, the coordinator could continue as a liaison between DNRC and NTPC, guaranteeing continued state monitoring of reclamation. SPCO would have a core staff of four people, consisting of:

1) Administrator—responsible for management, contracts, budget, billing, personnel, general coordinating, and final decision-making authority

2) Administrative specialist—handles administrative matters on design review, time keeping, scheduling, and contracts

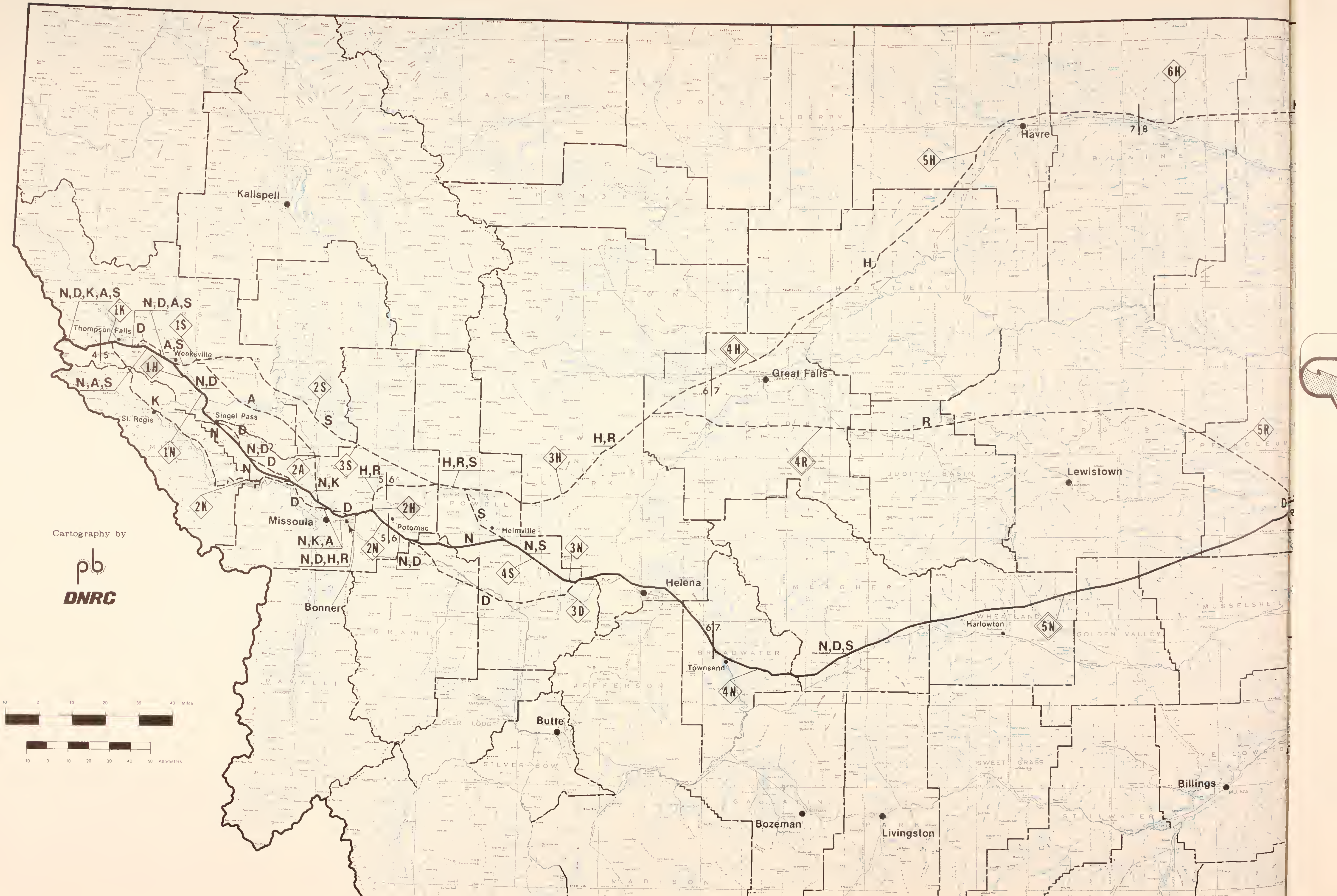
3) Environmental Section Chief—supervises field monitors, oversees all phases of environmentally related work, and is involved in design review

4) Engineering Section Chief—supervises field monitors, oversees all phases of engineering related work, and is involved in design review

Both section chiefs would have additional staff (consultants or state employees on loan) working as field monitors and design reviewers. The number of required personnel would not be known until the centerline evaluation is completed.

State surveillance on private land would be with the consent of the landowner, and could serve to advise the owner of proper construction and reclamation practices. Specifications such as restoration of disturbed areas required by state law would be considered minimum requirements. Any reclamation beyond the state's requirements would be negotiated between NTPC and the landowners.

MAP NO. TWO



Kalispell
Havre
Great Falls
Lewistown
Helena
Missoula
Bonner
Potomac
Helmville
Thompson Falls
Weeksville
St. Regis
Siegel Pass
Townsend
Harlowton
Butte
Bozeman
Livingston
Billings
N,D,K,A,S
N,D,A,S
N,A,S
A,S
N,D
N,K
N,K,A
N,D,H,R
H,R
H,R,S
N,S
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1K
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4R
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5N
5R
6H
Cartography by
DNRC
Miles
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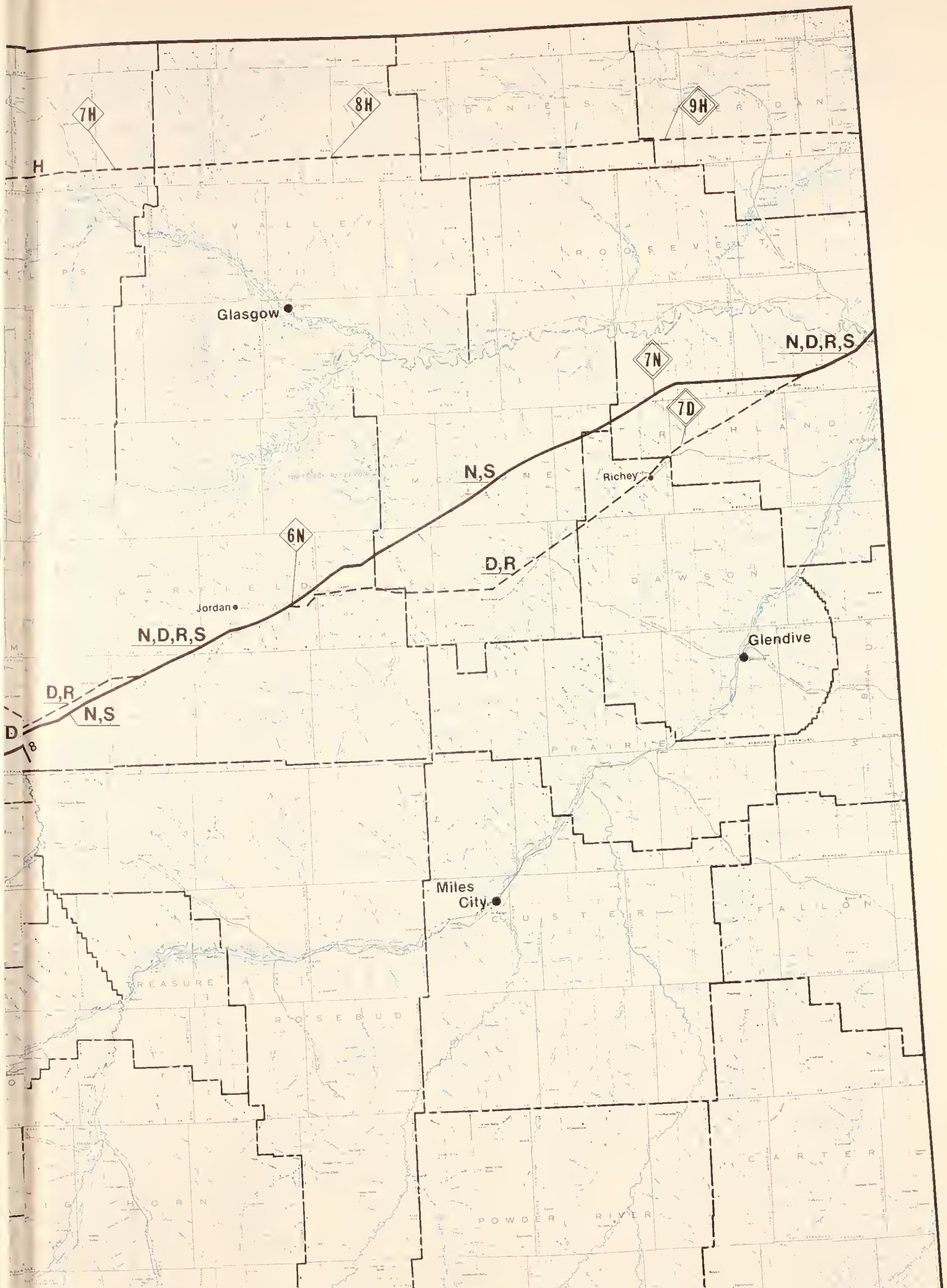


MAP NO. TWO

ROUTES EVALUATED

—— Northern Tier's Proposed Route (NTPR)

- - - - Alternatives to NTPR

◇ Pump Stations

◇ Pump and Delivery Stations

6|7 Construction Sections

ROUTE	PUMP STATIONS								
N– NTPR	1N	2N	3N	4N	5N*	6N	7N*		
D– DNRC Modified	1N	2N	3D	4N	5N*	6N	7D*		
K– Knox Pass	1K	2K							
A– Arlee	1S	2A							
H– Hi-Line	1H	2H	3H	4H*	5H	6H	7H	8H	9H*
R– Raynesford	1H	2H	3H	4R*	5R	6N	7D*		
S– St. Ignatius	1S	2S	3S	4S	4N	5N*	6N	7N*	

*Delivery Stations

Explanation

Only N, D, and S extend across the state.

K and A are defined only from Idaho to Bonner; east of Bonner they can follow any one of several alternatives.

H and R are defined only from Bonner to North Dakota; west of Bonner, they can follow any one of several alternatives.

◇ Pump stations 1H and 2H were engineered to follow D.

To follow a route, just follow the letters.
For example, to follow route D, find the first D indicated on the western end of the map, and then follow the routes marked with the letter D.
All combinations of routes considered in the evaluation are indicated on this map.

ROUTES EVALUATED

Surveillance Alternative A

Surveillance Alternative A would be the most complete monitoring plan and would consist of the following provisions:

1) SPCO would be established.
2) SPCO would review all final designs and issue a "notice to proceed" to NTPC prior to any construction.
3) Once construction begins, trained SPCO field inspectors would monitor all construction.
4) The field inspectors would have stop-work authority and could exercise it immediately.
5) If construction were stopped, the administrator of SPCO would take immediate measures to resolve the problem so that construction could proceed again as soon as possible.
6) NTPC would post a reclamation bond with SPCO that would be released upon successful revegetation.
7) SPCO would arrange to resolve any problems not adequately addressed by NTPC during construction, cleanup, reclamation, or oil-spill cleanup. A bill would then be submitted to NTPC, rather than having the company post a bond to be released upon completion of acceptable work.
8) After all construction, cleanup, and revegetation were deemed complete and acceptable, the office would maintain a skeleton staff to monitor reclamation and oil-spill cleanup.

Surveillance Alternative B

Surveillance Alternative B consists of the above provisions; however, these would apply only to specific sites identified during centerline selection. Other areas would be spot-checked.

Surveillance Alternative C

Surveillance Alternative C consists merely of current state authority. Compliance with permit conditions would be NTPC's responsibility. The only surveillance done by the state would be occasional checking by the permitting agencies in areas where permits or easements are issued. The agencies do have stop-work authority; however, they are constrained by lack of funds and personnel.

Surveillance Alternative D

A fourth surveillance alternative would consist of the provisions of alternative A, but would be administered by an independent consulting firm.

CHAPTER FOUR

SYSTEM ALTERNATIVES

MEPA requires that, along with the potential environmental impacts of a proposed action, an EIS must examine reasonable alternatives, including that of not building the proposed facility. It is essential to consider the need for the services provided by the pipeline to determine the impacts of not constructing the system. Thus, although no explicit finding of need is mandated by MEPA, it must be examined. The state has no authority to institute any of the described alternatives.

Historically, Montana refineries have been supplied with crude oil from Montana, Wyoming, and Canada. In 1978, the 3,800 m^3/d (24,500 bpd) obtained from Montana sources accounted for 18 percent of the crude oil refined in the state. The 7,630 m^3/d (48,000 bpd) contributed by Wyoming sources amounted to 37 percent. The greatest amount came from Canada—9,300 m^3/d (58,500 bpd) which represented 45 percent of the crude-oil runs to Montana refineries. These figures are typical of the proportions of crude oil obtained from the three sources since 1972.

Establishing alternative sources will be of prime importance within the next few years, due primarily to Canada's present intention to reduce its dependence on foreign crude sources through gradual reduction and cessation by 1982 of light crude exports to the United States. It is unknown at this writing whether the new government will continue this policy. If it does, the Montana refineries will be significantly affected because they have come to depend heavily on Canadian crude. This dependence grew over the years from less than 1 percent in 1962 to a high of over 46 percent in 1976; in fact, the 1976 high was attained after Canada's curtailment plans were announced in 1975. If no action is taken to replace the lost source of crude from Canada, Montana refineries could be operating at such low levels by 1982 that at least one of the larger refineries may be forced to halt operations.

Figure 2 shows the five-state area served by Montana's refineries. In 1978, 20,800 m^3/d (131,000 bpd) of crude were processed to serve Montana, eastern Washington, northern Idaho, western North Dakota, and northern Wyoming. This service area's demand for refined products grew at an average rate of 5 percent per year from 1960 to 1970 and at 2 percent from 1970 to 1977 (MERDI 1978). Montana's present refining capacity is 24,200 m^3/d (153,950 bpd) which could produce about 25,300 m^3/d (159,000 bpd) in product; product demand could possibly grow beyond this capacity.

FIGURE 2. MONTANA REFINERY MARKET AREAS

Source: USDOE 1979

Montana would not be the primary market served by the Northern Tier Pipeline; most of the crude oil would be delivered to Minnesota and the Midwest. Consideration of the Midwest crude market is addressed extensively in the USDOE study, **Draft Report - Petroleum Supply Alternatives to the Northern Tier and Inland States Through the Year 2000**, hereafter referred to as the "USDOE study" (USDOE 1979). DNRC's analysis is limited to the state of Montana and the market area dependent upon Montana's refineries for petroleum products. DNRC contacted the Montana refineries and information obtained from them is incorporated in this analysis.

DNRC's analysis of system alternatives begins with a projection of crude oil available to Montana refineries without any new attempt to increase supply. This projection is compared to the refineries' crude demand based on present capacity. The next issue addressed is the expected growth in demand for refined products in the Montana refineries' service area. A number of alternative ways to satisfy the need for additional crude are also examined. Some would require new construction and some would not. Construction alternatives include the Northern Tier Pipeline, the Kitimat Pipeline, the Alaska Highway Oil Pipeline, the Trans Mountain Pipeline, and unit train from the West Coast. Nonconstruction alternatives include conservation and fuel switching to reduce demand for refined products, enhanced recovery techniques and coal liquefaction to increase the total supply of crude oil, and reallocation of existing crude and refined product flows. Possible reallocations include continued reliance on exchanges with Canada, increased imports of refined products into the service area from Wyoming and the West Coast, and increased retention of Montana crude for use in Montana refineries.

The results of a preliminary benefit/cost analysis of each alternative is also presented. A benefit/cost analysis must be based on assumptions about the future which, although best estimates, are not certainties. The results of any benefit/cost analysis are based on the accuracy of the assumptions. A sensitivity analysis can identify the magnitude of error caused by inaccurate assumptions. Time constraints did not allow the inclusion of such an analysis here; however, one will be included in the final EIS. An additional limitation of a benefit/cost analysis is the inability to objectively or adequately give a dollar value to positive and negative nonmonetary effects of a project. This chapter specifies where judgments must be made about these values.

NEED

Crude Supply Projections

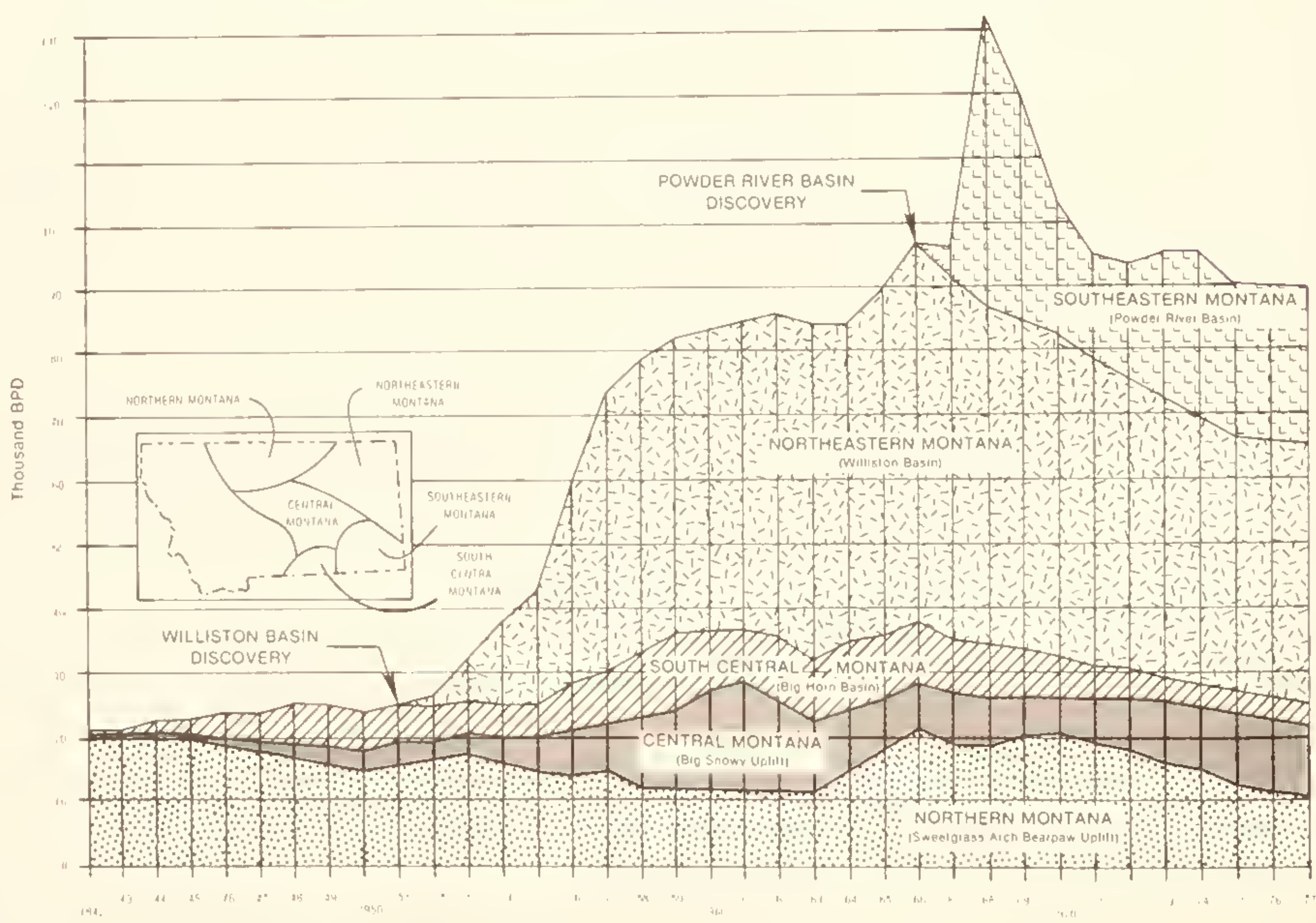
Available crude supplies for Montana refineries are limited by several factors: existing transportation facilities, technology, amount of crude produced, and the price refiners are willing to pay. When the price of domestic crude is deregulated, production from previously uneconomical wells and secondary and tertiary recovery methods will become economical—in some areas, at a minimum of $20 per barrel (using 1977 figures). (Crude presently can be transported by truck from the West Coast to Billings at a cost of about $7 per barrel, according to MERDI 1978.) The quantity of available crude can be further increased through synthetic production, from such sources as oil shale in Wyoming, Colorado, and Utah, and tar sands in Alberta, when increased price makes this economical.

Supply is examined here, however, without considering the effects of price increases other than the rise of domestic crude prices to world levels as a result of deregulation. Price increases are explicitly considered in the section entitled "Benefit/Cost Analysis," p. 30.

Montana Production Sources

Montana has five crude oil-producing areas: northern Montana (Sweetgrass Arch/Bearpaw Uplift), southcentral Montana (Big Horn Basin), central Montana (Big Snowy Uplift), northeastern Montana (Williston Basin), and southeastern Montana (Powder River Basin). Figure 3 delineates these areas and compares production from each from 1942 to 1977. Except for a small amount from northeastern Montana, only the northern, central, and southcentral areas supply crude to Montana refineries. Table 4 gives each area's production trend for the periods 1973-1976 and 1976-1977, as well as the weighted average of the two.

FIGURE 3. MONTANA CRUDE OIL PRODUCTION, 1942 TO 1977



CONVERSIONS 1 barrel = 42 U.S. gallons
1 U.S. gallon = .003785 m³

TABLE 4. MONTANA CRUDE PRODUCTION AND USAGE BY AREA

	PERCENTAGE OF MONTANA PRODUCTION (1977)	PERCENTAGE GOING TO MONTANA REFINERIES (1977)	ANNUAL PRODUCTION TREND PERCENTAGE DECLINE OR INCREASE[1] 73-76	76-77	Weighted Average[2]
Northern Montana	12	100	7	3	5
Central Montana	11	95	(3)	10	3.5
Southcentral Montana	4	45	4	3	3.5
Northeast Montana	45	6	1	(1)	0
Southeast Montana	28	0	(2)	(3)	(2.5)

[1] Parentheses indicate increase
[2] A 50 percent weighting is given to the most recent trend

TABLE 5. PROJECTED MONTANA CRUDE PRODUCTION (in bpd) AND ASSUMED PRODUCTION DECLINES OR INCREASES TO THE YEAR 2000

	Northern Montana		Southcentral Montana		Central Montana		Northeastern Montana		Southeastern Montana		Total DNRC Projected Production	Total USDOE Projected Production
Year	Projected Production	Production Decline or Increase Per Year	Projected Production	Production Decline or Increase Per Year	Projected Production	Production Decline or Increase Per Year	Projected Production	Production Decline or Increase Per Year	Projected Production	Production Decline or Increase Per Year		
1980	9500		3000		9100		40,100		26,900		88,600	92,900
1981	9100	5%	2900	3.5%	8700	3.5%	40,100	0	27,500	(2.5%)[1]	88,300	93,200[2]
1982	8600	5%	2800	3.5%	8400	3.5%	40,100	0	27,500	0	87,400	93,500[2]
1983	8200	5%	2700	3.5%	8100	3.5%	40,100	0	27,500	0	88,600	93,700[2]
1984	7800	5%	2600	3.5%	7800	3.5%	40,100	0	27,500	0	85,800	94,000[2]
1985	7400	5%	2500	3.5%	7500	3.5%	40,100	0	27,500	0	85,000	94,300
1990	5700	5%	2100	3.5%	6300	3.5%	33,500	3.5%	23,100	3.5%	70,700	95,800
1995	4400	5%	1700	3.5%	5300	3.5%	28,100	3.5%	14,300	3.5%	58,800	97,200
2000	3400	5%	1500	3.5%	4400	3.5%	23,500	3.5%	16,100	3.5%	48,900	95,800

CONVERSIONS 1 barrel = 42 U S. gallons
1 U S gallon = 003785 m^3

[1] Paranthese indicate increase
[2] Interpolated data

Table 5 projects the output of each area through the year 2000. Production projections were made using the weighted average of the 1973-1976 trend and the 1976-1977 trend, giving a 50 percent weighting to the most recent trend to allow for its assumed greater significance. Because these projections do not allow for new discoveries (additions to proven reserves), they are pessimistic. Also listed in table 5 are crude production projections made for Montana in the USDOE study; they are based on additions to proven reserves of crude oil and production declines of existing fields. The USDOE study projections represent a probable level, while the DNRC projections represent a worst-case situation.

Using the DNRC projections, it is possible to estimate the least amount of crude produced in the state that may be available to Montana's refineries if no pipeline is constructed and no efforts are made to increase crude supplies.

As previously stated, Montana refineries typically receive about 18 percent of their crude oil supply from local sources. This constitutes about 27 percent of Montana's annual production, with about 73 percent being exported to other states. USDOE regulations (the "Mandatory Petroleum Allocation and Price Regulations" mandated under the Emergency Petroleum Allocation Act of 1973, as amended) require that crude oil produced by an oil field continue to be available to the historical purchasers. Aware of the problem this creates, USDOE is considering changing its regulations to allow Montana refineries access to local crude oil (FEA 1977). This may not become necessary, however, because President Carter has proposed that Congress allow these regulations to expire in 1980. The least amount of Montana crude that may be available if USDOE regulations are not allowed to expire is projected in table 6. For comparison, the forecasts of the USDOE study also are presented.

TABLE 6. BASELINE ESTIMATES OF MONTANA CRUDE AVAILABLE TO MONTANA REFINERIES (in bpd)

	DNRC	DOE
1980	21,900	26,800
1981	21,100	26,900[1]
1982	20,200	27,000[1]
1983	19,500	27,000[1]
1984	18,800	27,100[1]
1985	18,100	27,200
1990	14,600	27,700
1995	11,900	28,100
2000	9,700	27,700

[1] Interpolated data

CONVERSIONS 1 barrel = 42 U S. gallons
1 U S gallon = 003785 m^3

Wyoming Sources

DNRC expects imports of crude oil from Wyoming to remain high, with the 1978 level maintained or possibly even increased, because: (1) the Exxon Pipeline from Wyoming to Billings is not being operated at full capacity of 10,200 m^3/d (64,000 bpd) (Polzin 1976); (2) the Conoco Pipeline from Byron, Wyoming, to Laurel, Montana, was redesigned for alternating reversal in 1976 to accommodate shipments of an additional 2,100 m^3/d (13,000 bpd) of crude from Wyoming (MERDI 1978); and (3) Wyoming production is expected to increase. Wyoming production was 48,700 m^3/d (306,200 bpd); in 1977 and increased to 57,200 m^3/d (360,000 bpd) in 1978 (WIEB 1979). Montana refineries received an average of 9,200 m^3/d (58,000 bpd) of Wyoming crude from 1975 to 1977; the greatest amount of Wyoming crude refined in Montana was 11,500 m^3/d (72,300 bpd) in 1969 (MERDI 1978). For this report, therefore, it was assumed that 9,500 m^3/d (60,000 bpd) of Wyoming crude would be available for the Montana refineries until the year 2000.

Table 7 gives USDOE's Wyoming crude production forecast. No forecast for Wyoming production was made by DNRC.

TABLE 7. WYOMING PRODUCTION PROJECTED BY U.S. DOE (in bpd)

1980	352,600
1985	358,100
1990	363,600
1995	369,100
2000	363,600

Canadian Export Allocation

The Canadian Crude Oil Allocation Program was adopted by USDOE to distribute the limited Canadian crude exports among U.S. users. The major Montana refineries (Conoco, Exxon, and Cenex) have been designated "Priority I" refineries, which receive the first allocations of Canadian crude. Montana's allocation for 1978 was 3,900 m^3/d (24,500 bpd) and is scheduled to remain at that level through 1981 when Canadian exports to the U.S. are to end.

Montana refineries actually increased use of Canadian crude in 1978 from the precurtailment volume of 9,190 m^3/d (57,800 bpd). This resulted from exchanging domestic for Canadian crude at a rate of 5,400 m^3/d (34,050 bpd). Exchanges are in excess of export allocation. With the exchanges added to Montana's 3,900 m^3/d (24,500 bpd) export allocation, use of Canadian crude in 1978 totaled 9,300 m^3/d (58,550 bpd). For further discussion of Canadian exchanges, see "Alternative Solutions, Exchanges with Canada," p. 28.

The schedule for cutbacks of crude exports is reviewed quarterly by the Canadian National Energy Board. It has been revised upward several times since the original schedule was presented in 1975. At present, there is speculation that the schedule may again be revised upward because Canadian crude production has been greater than expected and the Canadian Petroleum Association is urging that exports be increased (Froelich 1978).

Canada is also expected to continue exporting natural gas liquids (condensate) to Montana. These sometimes are used as refinery feedstock and sometimes as refined products. Because of the uncertainty of the level of these exports and their uses, they are not discussed in this chapter. USDOE projects that 1,600 m³/d (10,000 bpd) of natural gas liquids will be available to Montana through the year 2000.

Crude Demand Projections

Refinery Demand

Six refineries currently are operating in Montana: Westco (Cut Bank); Phillips (Great Falls); Kenco (Wolf Point); Exxon, Cenex, and Conoco (Billings area). Table 8 shows for each, the refining capacity, 1978 crude sources, and the 1978 average percentage of capacity utilization. Their total combined refining capacity is 24,500 m³/d (153,950 bpd), of which 90 percent is in the Billings area.

Demand for refined products comes from Montana, Washington, Idaho, North Dakota, and Wyoming. To continue supplying this service area economically, Montana's refineries must have enough crude to operate at a minimum of about 70 percent of capacity (107,800 bpd). (One of

TABLE 8. CAPACITY OF MONTANA REFINERIES AND AVERAGE UTILIZATION

	1979 REFINERY CAPACITY IN BPD	1978 CRUDE SOURCE (bpd) North Dakota	Montana	Wyoming	Canada	Changes in Storage	Total Refined	1978 AVERAGE PERCENTAGE OF CAPACITY UTILIZATION
Exxon	45,000	——	1,421	25,842	12,091	−332	39,686	88
Conoco	52,500	——	8,136	9,326	24,815	− 93	42,370	81
Cenex	40,400	176	2,793	12,813	20,139	+622	35,299	87
Phillips	6,000	——	4,305	——	1,500	+ 7	5,798	97
Kenco	4,750	14	2,634	——	——	0	2,648	76[1]
Westco	5,300	——	4,952	——	——	− 38	4,990	94
TOTAL	153,950	190	24,241	47,981	58,545	+166	130,791	86[1]

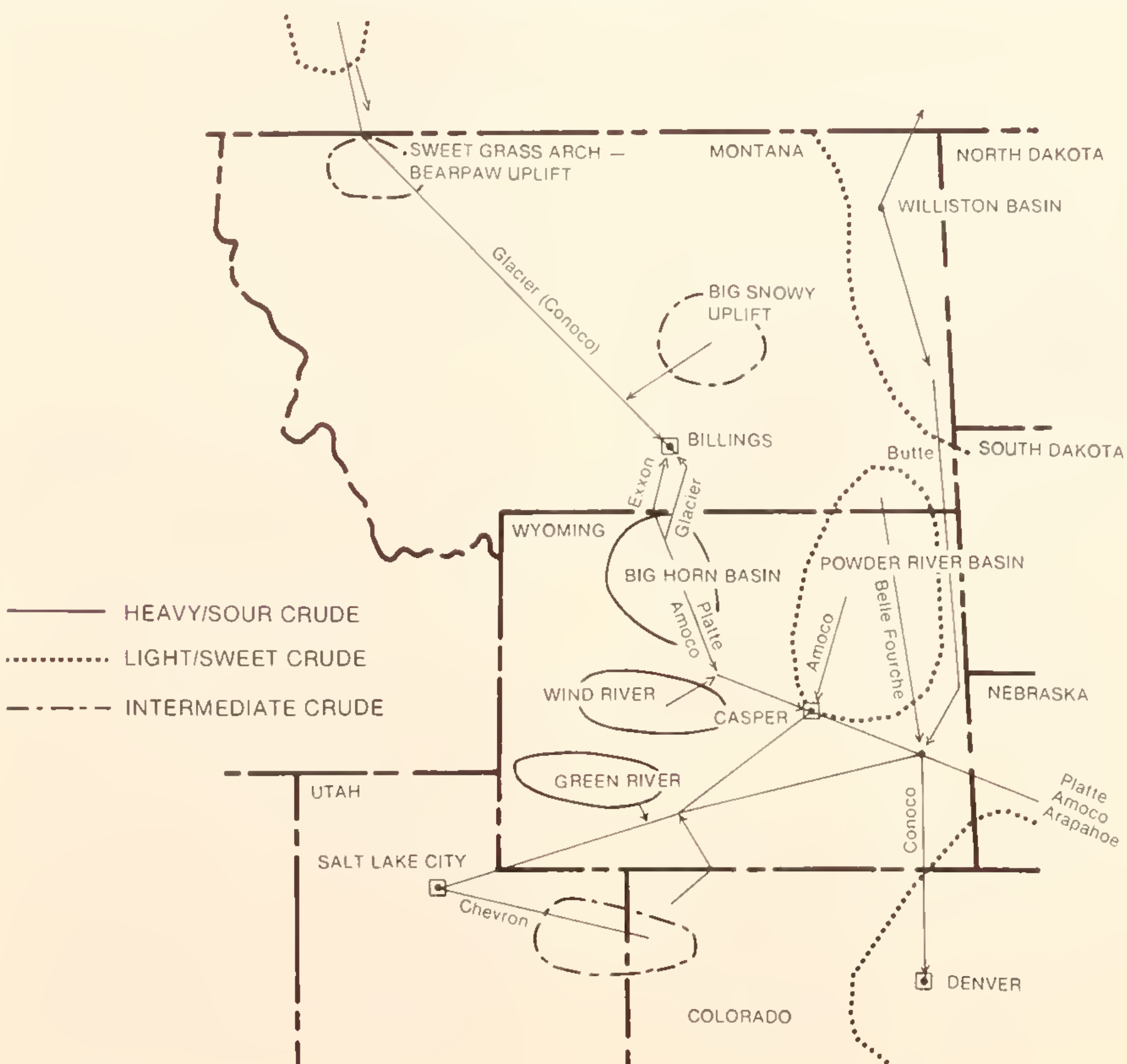
CONVERSIONS 1 barrel = 42 U S gallons
1 U S gallon = 003785 m³

[1] Percentage of capacity utilization given uses Kenco's 1978 capacity of 3,500 bpd, rather than the present capacity of 4750 bpd

Montana's refiners reported that it would cease operation when the amount of crude refined falls below 50 percent of capacity.)

Montana's refineries have varying abilities to process different types of crude oil. Wyoming (Big Horn Basin) crude is generally heavy with high sulfur content. The crude received from Canada is light with low sulfur content. Montana crude is primarily light with varying sulfur content and is generally a better substitute for Canadian crude than Wyoming crude (see figure 4). None of the refineries are able to process 100 percent Wyoming (Big Horn Basin) crude. Some refineries, however, would be better able to use Wyoming crude as a replacement for Canadian crude than others. Table 9 gives a comparison of several domestic and foreign crude characteristics. Light, sweet crudes are usually more desirable than heavy, sour crudes because of their more valuable product mix (i.e., the relative amounts of different refined products from a given amount of crude) and fewer pollution problems. (See footnote to table 9 for definitions of sweet, sour, heavy, and light.)

FIGURE 4. MONTANA/WYOMING CRUDE PRODUCTION AREAS AND PIPELINE SYSTEMS



Source FEA 1977

TABLE 9. COMPARISON OF CRUDE OIL CHARACTERISTICS

CRUDE	CHARACTERISTICS[1]
Alaskan North Slope	Heavy, Sour
Arabian (light)	Light, Sour
Canadian (Alberta)	Light, Sweet
Indonesian (Minas)	Light, Sweet
Iranian (light)	Light, Sweet
Mexican (Reforma)	Light, Sour
Montana (Williston Basin, Powder River Basin)	Light, Sweet
Montana (Sweetgrass Arch/ Bear Paw Uplift, Big Snowy Uplift)	Light, Sweet to Sour
Montana (Big Horn Basin)	Heavy, Sour
Wyoming (Big Horn Basin)	Heavy, Sour

[1] Heavy - Gravity less than 30° API (Specific gravity of .8762 at 60°F.)
Light - Gravity greater than 30° API (Specific gravity of .8762 at 60°F.)
Sour - Sulfur content greater than .5 percent
Sweet - Sulfur content less than .5 percent

Three petroleum demand forecasts were examined for this chapter: the Montana Energy Advisory Council's (MEAC) "**Energy Consumption in Montana: Projections to 1990,**" (MEAC 1976) the Pace Company's "**Crude Oil Supply/Demand Outlook for the Northern Tier and Midwestern States,**"

(Pace Co. 1978) and Bonner and Moore's "**Energy Demand Forecasts for the Northern Tier and Inland States**" (Bonner and Moore 1978). Except for the MEAC forecast (which did not explicitly consider petroleum prices) the forecasts assumed domestic crude price decontrol, but with constant real world prices. Also assumed was some future fuel substitution including use of additional nuclear and coal fuels. The three studies project refined product demand in Montana as shown in table 10.

DNRC synthesized petroleum demand projections for the refinery service area from the demand projections made for Montana. This was done by determining the annual historical ratio of total service area demand to Montana's demand. This was found to be between 1.9:1 and 2:1, averaging 1.94:1 since 1968. Assuming that this ratio remains constant, multiplying it by forecasted Montana crude demand gives the synthesized forecast for the service area demand, as shown in table 11.

Because the projections made for Montana and the other service area states reveal similar rates of demand growth, this report assumes that the average ratio will remain constant. The large Montana refiners in the Billings area also have indicated that Montana's share of the marketing area will remain constant.

Refinery Demand as Percentage of Capacity: Shortfalls

The term "shortfalls" in this chapter means transportation deficits. That is, shortfalls are a problem that could be solved by additional transportation capability (as opposed to a general crude oil shortage). In economic terms a shortfall is excess quantity demanded and would tend to drive prices upward in a normally functioning market.

This section examines Montana's refinery demand given the present capacity of 24,500 m³/d (153,950 bpd), and assumes that the refineries won't expand if sufficient crude supplies are not available. The refiners report that they probably would expand if crude supplies were to become available and if demand grows beyond current capacity. However, one refiner reports that government regulations and the cost of crude would influence its decision.

Available crude supply from Montana sources is shown in table 6, p. 23. Table 12 adds the 9,500 m³/d (60,000 bpd) of Wyoming crude assumed to be available, and gives the percentages of operating capacity these crude supplies would allow.

As stated before, Montana's refineries must operate at a minimum of approximately 70 percent of capacity to continue economically supplying their service area. It is clear from an examination of table 12 that it would not be possible for all refineries to continue operating after 1980 at baseline crude supplies even with Wyoming imports.

TABLE 10. PROJECTED REFINED PRODUCT DEMAND IN MONTANA (in bpd)

	LOW	BONNER AND MOORE INTERMEDIATE (MOST LIKELY)	HIGH	MEAC	PACE
1980	84,000	83,300	84,200	74,900	86,100
1981	85,700[1]	86,400[1]	86,400[1]	77,200[1]	87,100[1]
1982	87,400[1]	87,500[1]	88,600[1]	79,500[1]	88,000[1]
1983	89,200[1]	89,700[1]	90,900[1]	81,900[1]	88,900[1]
1984	91,000[1]	91,700[1]	93,200[1]	84,400[1]	87,900[1]
1985	92,800	94,200	95,600	86,900	90,900
1990	100,400	103,300	106,500	99,500	94,600
1995	107,600	111,700	115,700	n/a	103,500[1]
2000	115,400	120,800	125,900	n/a	113,300

CONVERSIONS 1 barrel = 42 U.S. gallons
1 U.S. gallon = 003785 m³
[1] Interpolated data

TABLE 11. PROJECTED REFINED PRODUCT DEMAND FOR MONTANA'S REFINERY SERVICE AREA (in bpd)

	BONNER AND MOORE INTERMEDIATE (MOST LIKELY)	MEAC	PACE
1980	161,600	145,300	167,000
1981	165,700	149,800	168,800
1982	169,800	154,200	170,700
1983	174,000	158,900	172,500
1984	178,300	163,700	174,400
1985	182,800	168,600	176,400
1990	200,400	193,000	183,500
1995	216,700	— —	200,800
2000	234,400	— —	219,800

CONVERSIONS 1 barrel = 42 U.S. gallons
1 U.S. gallon = 003785 m³

Even if crude is available to run the refineries at or near capacity, this may not be sufficient to supply the demand for refined product in the service area. Refined product demand is expected to surpass refining capacity by 1980 (of the three projection studies, only MEAC's synthesized figures do not forecast demand to exceed capacity by 1980). To meet this demand, crude must be available to allow Montana refining capacity to expand, refined products must be shipped into the service area from outside, or refining capacity must be constructed in the service area outside Montana.

A worst-case refined product supply forecast includes: the refinery crude supply assumed available (table 12); refinery gain (approximately a 5 percent volume increase in refinery output over input); and refined product shipments from outside the service area which are assumed to be available at the current shipment level of 800 m³/d (5,000 bpd) of product from Wyoming on the Husky (Shoshone) Pipeline. By pairing both the lowest and the highest product demand indicated by the three projection studies in table 11 with this worst-case supply, a shortfall range is obtained for the projected worst case. This range is shown in table 13.

TABLE 12. PROJECTED REFINERY CRUDE SUPPLY INCLUDING WYOMING IMPORTS (in bpd) AND PERCENTAGE OF REFINERY CAPACITY

	BASELINE SUPPLY (BPD)				
	Montana	Wyoming	Canada	Total	PERCENTAGE OF CAPACITY
1980	21,900	60,000	24,500[1]	106,400	69
1981	21,100	60,000	24,500[1]	105,600	69
1982	20,200	60,000	0	80,200	52
1983	19,500	60,000	0	79,500	52
1984	18,800	60,000	0	78,800	51
1985	18,100	60,000	0	78,100	51
1990	14,600	60,000	0	74,600	48
1995	11,900	60,000	0	71,900	47
2000	9,700	60,000	0	69,700	45

CONVERSIONS: 1 barrel = 42 U.S. gallons
1 U.S. gallon = 003785 m³
[1] Canadian export allocation

This chapter's analysis of crude supply and demand in Montana establishes that additional crude will be needed by 1980 to enable Montana's refineries to operate economically. To keep pace with the service area's demand for refined products, additional crude will be needed by Montana's refineries, or additional product will have to be shipped into the service area from outside, or additional refining capacity will have to be built in the service area outside of Montana.

TABLE 13. REFINED PRODUCT SHORTFALL RANGE AT WORST-CASE SUPPLY SITUATION (in bpd)

	PROJECTED DEMAND			WORST-CASE SUPPLY	SHORTFALL	
	Bonner & Moore	MEAC	PACE		Low	High
1980	161,600	145,300	167,000	116,700	28,600	50,300
1981	165,700	149,800	168,800	115,900	33,900	52,900
1982	169,800	154,200	170,700	89,200	65,000	81,500
1983	174,000	158,900	172,500	88,500	70,400	85,500
1984	178,300	163,700	174,400	87,700	76,000	92,600
1985	182,800	168,600	176,400	87,000	81,600	95,800
1990	200,400	193,000	183,500	83,300	100,200	117,100
1995	216,700	——	200,800	80,500	120,300	136,200
2000	234,400	——	219,800	78,200	141,600	156,200

CONVERSIONS: 1 barrel = 42 U.S. gallons
1 U.S. gallon = .003785 m³

ALTERNATIVE SOLUTIONS

The alternative solutions discussed below are of two kinds—those that would require new construction and those that would not.

Construction Alternatives

Figure 5 shows the crude oil pipeline system connecting to Montana. The five proposed construction alternatives discussed below involve tying into the network at some point to facilitate delivery of crude to Montana refineries.

Due to the design characteristics of Montana refineries and the poor marketability of heavy bottom products (e.g., residual oil and asphalt more of which are produced by heavy crude than by light), the refineries are limited in the amount of heavy crude they can refine. Wyoming (Big Horn Basin) and Alaskan North Slope (ANS) crude are both heavy. Montana refiners are likely to continue using Wyoming crude, so the amount of ANS crude that would be used in Montana, if available, may not be great. The construction alternatives would give Montana refineries access to Indonesian and Persian Gulf light crudes.

Table 14 shows the estimated tariffs for each of the proposals at different throughput levels. Any additional tariff for delivering crude to Billings is also shown. It is possible that, even if one of the construction alternatives is built, some refiners (especially those in markets east of Montana) would continue to purchase crude elsewhere. To cover revenue from the reduced volumes, the tariff would have to be increased, thereby hindering the project's competitive viability. This aspect was considered in the USDOE study by comparing the rates of return on each of the projects. Such consideration is beyond the scope of this EIS.

Northern Tier Pipeline

Based on 1978 cost estimates and full-capacity throughput, NTPC's tariff estimate is $0.51 (1977 dollars) per barrel delivered at the Glacier Pipeline. Using the latest 1979 cost estimates, DNRC estimated tariffs at $0.63 per barrel at 148,300 m³/d (933,000 bpd) total throughput, $0.77 per barrel at 113,000 m³/d (709,000 bpd), $1.07 per barrel at 80,000 m³/d (500,000 bpd), and $1.51 per barrel at 55,600 m³/d (350,000 bpd). An additional tariff to Billings on the Glacier Pipeline is estimated by USDOE at $0.20 per barrel (figures in 1979 dollars).

Trans Mountain Pipeline

The Trans Mountain Pipeline Company proposes a 76-cm (30-in) diameter pipeline from a port at Low Point, Washington, to Edmonton, Alberta. The pipeline would be constructed parallel to and in the same corridor as Trans Mountain's existing 61-cm (24-in) pipeline from Edmonton to Anacortes, Washington, reducing requirements for new right-of-way to less than 161 km (100 mi). The pipeline would be almost 1328 km (825 mi) long, of which approximately 241 km (150 mi) would be in Washington and 1087 km (675 mi) would be in Canada. From Edmonton, crude could be delivered to Billings via the Rangeland/Glacier pipleine system and to other Northern Tier and Midwest states via the Interprovincial/Lakehead system and other pipeline system connections. The pipeline would have a capacity of 79,500 m³/d (500,000 bpd). No new construction would be required in Montana. Using the latest Trans Mountain Pipeline Company cost estimates, DNRC estimates the tariff from Low Point to Edmonton to be $1.20 per barrel at 55,600 m³/d (350,000 bpd) and $0.86 per barrel at 79,500 m³/d (500,000 bpd) There would be an additional tariff, of $0.691 per barrel on an existing system from Edmonton to Billings.

TABLE 14. ESTIMATED TARIFFS TO BILLINGS ($/barrel)

	THROUGHOUT (BPD)				
	48,000	350,000	500,000	709,000	933,000
Northern Tier					
Port Angeles to Glacier Pipeline	——	$1.51 [1]	$1.07 [1]	$ .77 [1]	$ .63 [1]
Glacier Pipeline to Billings	——	.20 [2]	.20 [2]	.20 [2]	.20 [2]
TOTAL	——	$1.71	$1.27	$ .95	$ .83
Trans Mountain					
Low Point to Edmonton	——	$1.20 [1]	$ .86 [1]	——	——
Edmonton to Billings	——	.691 [3]	.691 [3]	——	——
TOTAL	——	$1.891	$1.551	——	——
Alaska Highway (Foothills)					
Skagway to Edmonton (via Keg River)	——	$2.31 [1]	$1.81 [1]	——	——
Edmonton to Billings	——	.691 [3]	.691 [3]	——	——
TOTAL	——	$3.001	$2.501	——	——
Kitimat					
Kitimat to Edmonton	——	$1.08 [1]	$ .77 [1]	——	——
Edmonton to Billings	——	.691 [3]	.691 [3]	——	——
TOTAL	——	$1.771	$1.461	——	——
Unit Train					
Port Westward to Cut Bank	$2.54 [2]	——	——	——	——
Cut Bank to Billings	.29 [3]	——	——	——	——
TOTAL	$2.83	——	——	——	——

CONVERSIONS: 1 barrel = 42 U.S. gallons
1 U.S. gallon = .003785 m³

[1] Estimated by DNRC
[2] Estimated by USDOE
[3] Published tariff

Alaska Highway Oil Pipeline Project (Foothills)

This is a proposed 1142-km-long (710-mile-long), 86-cm-diameter (34-in-diameter) pipeline from Skagway, Alaska, to Keg River, Alberta. By paralleling existing railroad and highway rights-of-way, as well as the proposed Alaska Highway Pipeline Project over much of its route, the need for new right-of-way would be reduced. From the Keg River terminal, existing pipelines would carry crude to Edmonton, where connections with the Rangeland and Interprovincial pipelines could transport crude to the Northern Tier and Midwestern states. The system would have a capacity of 79,500 m^3/d (500,000 bpd). No construction would be required in Montana. The tariff from Skagway to Edmonton via Keg River is estimated at $1.81 per barrel at 79,500 m^3/d (500,000 bpd) and $2.31 per barrel at 55,600 m^3/d (350,000 bpd). An additional $0.691 per barrel would be required from Edmonton to Billings. Sponsors of the project are Northwest Energy Company and Foothills Oil Pipeline Ltd.

Kitimat Pipeline

The Kitimat Pipeline from Kitimat, British Columbia, to Edmonton, Alberta, would include a port at Kitimat and 1212 km (753 mi) of 91-cm-diameter (36-in-diameter) pipeline paralleling existing natural gas and crude oil pipeline rights-of-way over much of the distance. Connections with the Interprovincial and Rangeland pipelines at Edmonton would allow the crude to be transported to other markets, including Montana. Volumes of up to 79,500 m^3/d (500,000 bpd) could be delivered to Edmonton by this pipeline. No new construction would be required in Montana to receive crude through the Kitimat Pipeline. Sponsors of this pipeline are Kaiser Resources Ltd., Ashland Oil, Inc., Continental Pipelne Co., Interprovincial Pipeline Ltd., and SOHIO. Tariffs to Edmonton are estimated to be $1.08 per barrel at 55,600 m^3/d (350,00 bpd) throughput, and $0.77 per barrel at 79,500 m^3/d (500,000 bpd), with an additional $0.691 per barrel tariff from Edmonton to Billings. This proposal is currently inactive as the Canadian government has stated the need for a West Coast tanker port has not been demonstrated.

Unit Train Proposal

The unit train proposal made by Burlington Northern, GATC, and GATX Terminals Corporation would allow the transportation of 7,630 m^3/d (48,000 bpd) of crude on existing Burlington Northern railroad lines from a port facility at Port Westward, Oregon, to Cut Bank, Montana, where it would connect with the Glacier Pipeline. As railroad lines in good condition already exist from Portland to Cut Bank, as does a port facility at Port Westward, the only construction needed would be upgrading of the port facilities and track from Port Westward to Portland, the construction of the terminal at Cut Bank, and manfacturing of the tank cars. The tariff from Port Westward to Cut Bank on GATX is estimted by USDOE to be $2.54 per barrel in 1979 dollars. An additional $0.29 would be required from Cut Bank to Billings.

Nonconstruction Alternatives

Several alternatives not involving the construction of new crude transportation facilities exist for solving the potential shortage to the Montana refinery service area. They include conservation and fuel switching, enhanced recovery techniques and coal liquefaction, diversion of crude currently flowing elsewhere, and market solutions.

FIGURE 5. MAJOR U.S. CRUDE OIL PIPELINES

SOURCE: USDOE 1979

Conservation and Fuel Switching

To some extent, the possibilities for conservation and fuel switching are embodied in the demand projections. These projections are based on assumed levels of the real price of crude oil and explicit assumptions about the growth of the economy and the possibilities of use and substitution of petroleum. Reduction in the demand for petroleum could result if price increases greater than expected were to occur, or if mandatory conservation measures or fuel switching measures were to be adopted. For example, a reduction in the speed limit to 80 km per hour (50 mi per hour) would reduce vehicular fuel consumption; a mandatory insulation program for oil-heated buildings would reduce fuel oil demand for heating purposes.

Enhanced Recovery and Coal Liquefaction

Increased exploration and discovery or enhanced recovery techniques can augment crude supplies, thereby reducing or eliminating shortages. Supply could also be increased by policy measures offering tax advantages and other incentives. To some extent, supply increases will result from rising prices, although the supply forecasts given in this chapter do not consider such effects; for this reason, they may be conservative.

Additional supplies of crude oil could be obtained by investment in coal liquefaction technology. Currently, this is not a feasible option, as it would be highly expensive. However, as world crude prices rise, or with federal subsidy or investment programs, such as President Carter's proposed Energy Security Corporation, it could become economically viable before the end of this century.

Market Solutions

Another nonconstruction alternative is the market solution by which market forces alone would balance the supply and demand of petroleum products in Montana. Pipeline construction oriented towards profit is a market solution. Since the state does not have direct access to a tanker port, the price of crude oil in Montana could rise above the world price. This could continue until the difference was great enough to reduce demand and attract additional supplies into the state eventually eliminating shortages. An upper limit to the size of this differential might be $7 per barrel, the cost of hauling crude by truck from the West Coast.

Reallocations of Crude Supply

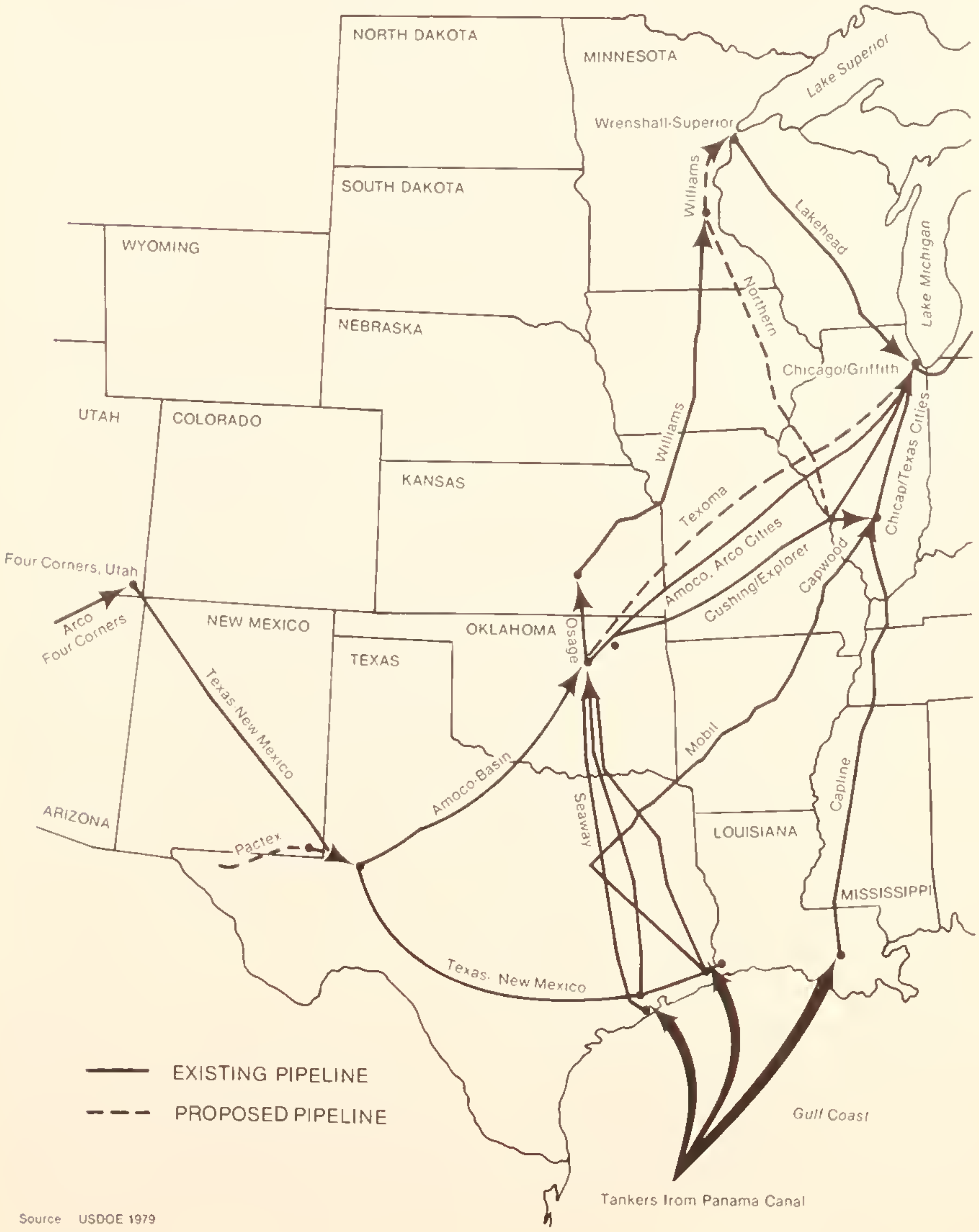
Two approaches may be taken to increase the amount of crude available to Montana refineries—exchanges with Canada and increased retention of Montana crude.

Exchanges with Canada. Under the exchange program, crude is delivered to Canada at a point useful to Canadian refiners in return for Canadian crude delivered to a particular place in the U.S. Most exchanged U.S. crude is delivered up the mid-continent pipeline system (see figure 6) to Sarnia, Ontario, or through the Portland Pipeline (from Portland, Maine) to Montreal in return for Alberta crude delivered down the Rangeland and Glacier pipelines to Billings. It is likely that crude oil exchanges between the U.S. and Canada will continue. Canada has crude surplus areas (western Canada) and crude deficient areas (eastern Canada), just as the U.S. does; therefore crude exchanges are desired by Canadian refiners. The high cost of transporting crude from western to eastern Canada was a major reason for instituting the exchanges (Robert R. Nathan Associates, Inc. 1979). The cost of exchanges is not excessive when compared to transportation costs without exchanges. In addition, if exchanges were stopped, production of some Canadian crude would have to be dropped below the optimal level because pipeline capacity from western to eastern Canada would be too small to transport the required amounts.

During the first four months of 1979, 7,400 m³/d (46,500 bpd) of domestic crude was exchanged for Canadian crude. DNRC assumes, therefore, that a conservative estimate of continued exchange would be 6,400 m³/d (40,000 bpd).

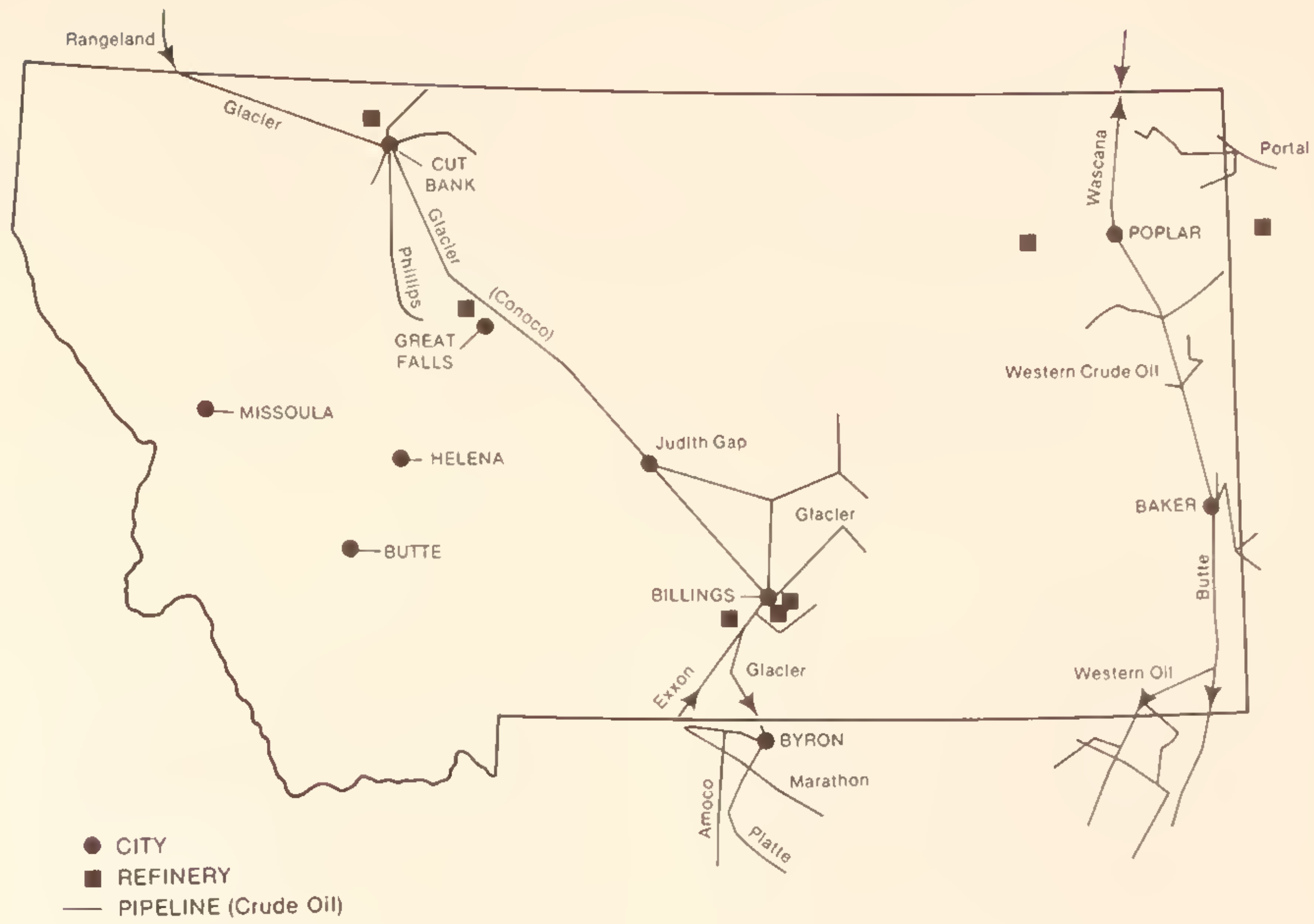
In December 1978, 365 m³/d (2,300 bpd) was shipped to Canada on the Wascana Pipeline from the Williston Basin in exchange for Canadian crude to Billings (Western Crude Oil 1979). Since this pipeline currently has a spare capacity of 5,200 m³/d (32,700 bpd), it could be used for further exchanges.

FIGURE 6. MID-CONTINENT PIPELINE SYSTEM



Source USDOE 1979

FIGURE 7. MONTANA CRUDE OIL PIPELINES



The mid-continent system is operating near capacity, but several expansions are planned which will allow accommodation of exchanges. In addition, the Portland Pipeline is operating at 44,800 m^3/d (282,000 bpd) below capacity, which also could be used for exchanges (FEA 1977). The Canadian government has established conditions to do this and did allow greater exchanges after the recent political turmoil in Iran reduced the supply of crude to Canada's east coast. However, it is not clear if the Canadian government will continue this policy. One refinery in Montana is currently exchanging foreign for Canadian crude at the rate of 2,500 m^3/d (15,800 bpd). If Canada would allow exchanges to fill the Portland Pipeline, Montana refineries could be supplied indefinitely, possibly postponing the need for obtaining greater access to local production.

Increased Retention of Montana Crude. Historically, only 27 percent of the crude from state sources has been available to Montana refineries; the remainder is exported to other states. As explained in the discussion on Montana production sources, present USDOE regulations do not allow Montana additional access to its local production. If the USDOE regulations expire as planned, or are changed, the problem remains of finding new sources of crude for the historical purchasers. This is feasible as 84 percent of the crude exported from Montana goes to Pennsylvania, Illinois, Indiana, Kansas, Missouri, Nebraska, Ohio, Colorado, Wyoming, and Utah—all of which have access to the mid-continent pipeline system or their own local production. The proposed expansion of the mid-continent system could offset the loss of Montana crude to these states or could supplement their own local production. The other 16 percent is shipped to Minnesota, Wisconsin, and North Dakota, for which alternative sources may be more difficult to find.

Currently there is no direct pipeline to transport crude from northeastern and southeastern Montana, the largest crude-producing areas in the state, to the major refining center in Billings. Except for a small volume sent by truck to the Wolf Point refinery, all crude from these areas leaves the state. One economical way to gain access to Williston Basin crude in northeastern Montana would be to make use of the Wascana Pipeline, a line currently sending crude oil north from Poplar, Montana (see figure 7), with a capacity of 5,600 m^3/d (35,000 bpd) (Polzin 1976). Since this pipeline presently has a spare capacity of 5,200 m^3/d (32,700 bpd), it could be used to exchange Williston Basin crude for Canadian crude shipped on the Glacier Pipeline to Billings. No easy solution exists, however, for transporting crude from the Powder River Basin in southeastern Montana to the major refineries. Some existing pipelines could be reversed to allow access to the area, but this would involve new investment, as would construction of a pipeline or unit train carrier directly from the Powder River Basin to the Billings area. Continental Oil Company has suggested full reversal of the Platte system in Wyoming to obtain access to the Powder River Basin by Montana refineries (see figures 4 and 5).

Montana's other crude-producing areas are directly connected by pipeline to the major refineries. If USDOE regulations expire or are amended, or if they are renewed and new sources can be found for the historical purchasers, 100 percent of the production from northern, central, and southcentral Montana could be obtained for Montana refineries.

Table 15 shows two levels of local production that could become available to Montana refineries as a result of increased retention of Montana crude. Level A shows how much Montana crude would be available if, in addition to the historical levels, 5,200 m^3/d (32,700 bpd) of northeastern Montana crude were exchanged via the Wascana Pipeline and 100 percent of central and southcentral Montana production were obtained for Montana refineries (see table 4, p. 22, for historical levels). Level B shows how much crude would be available if 100 percent of all Montana crude production were allocated to Montana refineries.

Total Crude Levels Possible From Reallocations. The crude supply projections given in this chapter show a baseline availability to be expected (table 6, p. 23) if no measures are taken to increase supply. Table 16 adds to these projections estimates of crude that could be obtained through additional retention of local production, exchanges with Canada, and imports from Wyoming. The intermediate level consists of 100 percent of the production from the northern, central, and southcentral Montana; 6 percent of production from the Williston Basin (this is the historical level trucked to the refineries); 5,200 m^3/d (32,700 bpd) from Williston Basin exchanged with Canada via the Wascana and Glacier lines; 9,500 m^3/d (60,000 bpd) from Wyoming; 3,900 m^3/d (24,500 bpd) from Canadian export allocation through 1981; and 6,400 m^3/d (40,000 bpd) from other Canadian exchanges. Besides the above figures, the high level includes 100 percent of all local production.

TABLE 15. AVAILABILITY OF LOCAL CRUDE (in bpd) TO MONTANA REFINERIES: TWO POSSIBLE LEVELS

	LEVEL A 32,700 bpd exchanged via Wascana Pipeline; 100 percent Northern, Central and Southcentral Production and 6 percent of Northeast Production	LEVEL B 100 Percent of All Local Production
1980	56,700	88,600
1981	55,800	88,300
1982	54,900	87,400
1983	54,100	86,600
1984	53,300	85,800
1985	52,500	85,000
1990	47,600[1]	70,700
1995	39,500[1]	58,800
2000	32,800[1]	48,900

CONVERSIONS 1 barrel = 42 U.S. gallons
1 U.S. gallon = .003785 m^3

[1] The Wascana Pipeline shipments drop below capacity because northeastern Montana production falls below that level

TABLE 16. CRUDE SUPPLIES AVAILABLE THROUGH REALLOCATIONS (in bpd)

	INTERMEDIATE LEVEL[1]					HIGH LEVEL[2]				
Source	1980	1985	1990	1995	2000	1980	1985	1990	1995	2000
Montana	56,700	52,300	47,600	39,500	32,800	88,600	85,000	70,700	88,800	48,900
Wyoming Imports	60,000	60,000	60,000	60,000	60,000	60,000	60,000	60,000	60,000	60,000
Canadian Export Allocation	24,500	0	0	0	0	24,500	0	0	0	0
Exchanges	40,000	40,000	40,000	40,000	40,000	40,000	40,000	40,000	40,000	
TOTAL	181,200[3]	152,500	147,600	139,500	132,800	213,000[3]	185,000[3]	170,700[3]	158,800[3]	148,900

CONVERSIONS 1 barrel = 42 U S gallons
1 U S gallon = 003785 m³

[1] The intermediate level is based upon estimates of 100 percent of the production from northern, central, and south central Montana, 6 percent of the production from northeastern Montana, 32,700 bpd in exchanges on on the Wascana and Glacier pipelines; 60,000 bpd in imports from Wyoming, 24,500 bpd from the Canadian export allocation through 1981, and 40,000 bpd in other Canadian exchanges

[2] The high level uses the same figures indicated at the intermediate level except that 100 percent of all Montana production is estimated

[3] These amounts exceed Montana's current refinery capacity of 153,950 bpd

Reallocation of Refined Products

Refined products (mostly gasoline and distillates) currently are transported into the Montana refinery market area in three ways: via the Chevron Pipeline from Salt Lake City to eastern Washington, via barge on the Columbia River to eastern Washington, and via the Husky Pipeline from Wyoming to Billings, delivered into the Yellowstone Pipeline. The Chevron Pipeline currently is operating at capacity, but another 5,100 m³/d (32,200 bpd) could be barged on the Columbia River (the capacity of the locks on the river limits the amount of barge traffic) and 2,400 m³/d (15,000 bpd) could be provided on the Husky line. Table 17 adds these amounts to the crude supply levels given in table 16 to obtain refined product supply equivalents; a refinery gain of 5 percent is assumed.

Reversal of the Conoco (Seminoe) line between Billings and Sinclair, Wyoming, would permit an additional 5,500 m³/d (34,800 bpd) of refined product to arrive at Billings. Table 18 compares the Bonner and Moore and Pace forecasts of refined product demand with the supply projected including the reallocations described above. A shortfall is not foreseen until 1995. If the Conoco (Seminoe) Pipeline were then reversed, there would be no shortage until 2000.

One adjustment must be made to these estimates of refined product shortfalls. Bonner and Moore's demand forecasts are based upon the assumption of constant real crude prices at $16.55 per barrel, the average acquisition cost in 1979 dollars to refiners of imported crude. It is unlikely that this assumption will remain valid. The USDOE study provides forecasts of world crude prices that permit construction of an estimated real price index for crude at Billings. Assuming that crude currently accounts for half the cost of refined product[1], it is possible to construct an equivalent real price index for products (table 19).

This index is used to adjust Bonner and Moore's price of $16.55 per barrel and its demand estimates. The adjusted Bonner and Moore estimates are compared in table 20 with the intermediate and high supply projections, including reallocations. With the adjusted demand estimates the shortfall is eliminated completely through the year 2000 with the Conoco (Seminoe) Pipeline reversal.

BENEFIT/COST ANALYSIS

An analysis was made of the benefits and costs to Montana of each alternative for which there were reliable cost of service estimates. This includes all five construction alternatives and, of the nonconstruction alternatives, reallocation.

A benefit/cost analysis is a useful method for comparing a number of project alternatives. However, it does have limitations. A benefit/cost analysis is based on assumptions about and best estimates of an uncertain future; therefore, the results are predicated on the accuracy of the assumptions. It is also difficult to objectively or adequately give a dollar value to the positive and negative nonmonetary effects of a project.

It is important to note that this benefit/cost analysis is only for Montana. Benefits and costs to Montana resulting from one of the alternatives may not be considered benefits and costs to the nation. Some may be transfers from other areas to Montana; for example, property taxes paid in Montana would be benefits transferred from elsewhere and would not be counted in a national benefit/cost analysis. The results of an analysis based on national need may significantly differ from DNRC's analysis.

[1]This may overestimate noncrude costs Noncrude costs of about $10 per barrel (1979 dollars) are estimated using national price and market data from the Energy Information Administration's "Annual Report to Congress, Volume III, 1977" For this reason, DNRC's demand adjustments may be conservative

TABLE 17. REFINED PRODUCTS AVAILABLE THROUGH REALLOCATIONS (in bpd)

	INTERMEDIATE LEVEL					HIGH LEVEL				
Source	1980	1985	1990	1995	2000	1980	1985	1990	1995	2000
DNRC Estimated Crude Supply	181,200[1]	152,500	147,600	139,500	132,800	213,100[1]	185,000[1]	170,700[1]	158,800[1]	148,900
Refinery Gain of 5 Percent	9,100	7,600	7,400	7,000	6,700	10,700	9,300	8,500	7,900	7,500
Additional Product from Husky Pipeline	15,000	15,000	15,000	15,000	15,000	15,000	15,000	15,000	15,000	15,000
Additional Product from Barging on the Columbia River	32,200	32,200	32,200	32,200	32,200	32,200	32,200	32,200	32,200	32,200
TOTAL	237,500	207,300	202,180	193,700	186,600	271,000	241,500	226,400	213,900	203,600

CONVERSIONS 1 barrel = 42 U S gallons
1 U.S gallon = 003785 m³

[1] This crude supply exceeds Montana's current refinery capacity of 153,950 bpd

TABLE 18. COMPARISON OF REFINED PRODUCT SUPPLY AND DEMAND PROJECTIONS WITH REALLOCATIONS (in bpd)

	PROJECTED DEMAND		PROJECTED SUPPLY		SHORTFALL		ADDITIONAL PRODUCT IF CONOCO (SEMINOE) PIPELINE WERE REVERSED[2]	
	Bonner & Moore[1]	Pace	Intermediate	High	Intermediate	High	Intermediate	High
1980	161,600	167,000	237,500	271,000	0	0	——	——
1985	182,800	176,400	207,300	241,500	0	0	——	——
1990	200,400	183,500	202,180	226,400	0	0	——	——
1995	216,700	200,800	193,700	213,900	2,800	23,000	34,800	34,800
2000	234,400	219,800	186,600	203,600	30,800	47,800	34,800	34,800

CONVERSIONS: 1 barrel = 42 U.S. gallons
1 U.S. gallon = .003785 m^3

[1] This column contains Bonner and Moore's intermediate demand projections.
[2] A reversal of the Conoco (Seminoe) Pipeline is possible but not highly probable; for this reason, the figures are not included in the projected supply.

Measurements of Benefits and Costs

This analysis makes distinctions between four types of benefits and costs: internal and external to the project and monetary or nonmonetary.

An internal cost is one which must be paid by the owner of the project and would therefore be added to the tariff charged for transporting crude. For example, the cost of the steel pipe which is included in the capitalized cost of the project, is apportionately added to each year's revenue requirement and the per-barrel tariff. An external cost is one not paid by the owner but rather borne by others or by the environment. An example of an external cost is the increased cost of electricity to all consumers resulting from the high cost of new generating facilities being averaged into electrical rates.

Similarly, an external benefit is one which does not accrue only to the purchaser of crude. An external benefit to Montana consumers of a crude oil pipeline might be increased security of refined product supply. This benefit does not result from purchasing the services of the pipeline but from the assurance that it will be possible in the future.

A monetary cost or benefit is one that has a market value. Construction labor would be a monetary cost, while the value to the purchaser of crude delivered at Billings would be a monetary benefit. A nonmonetary cost or benefit is one without a market dollar value. Changes in land use patterns due to the risk of oil spills represent nonmonetary costs. Security of supply is a nonmonetary benefit.

In this analysis, all benefits and costs for which monetary values can readily be found are added together, whether internal or external. The system alternatives are ranked according to the results. Nonmonetary benefits and costs of the alternatives are then compared. Monetary value would have to be assigned by society to the differential nonmonetary net benefits to change the relative rankings of the alternatives. Since the weighting given to nonmonetary benefits and costs results, to a large extent, from political and social choices, it would be inappropriate to assign a weighting for this analysis. Instead, ranges of weightings over which rankings remain stable and over which they change are discussed.

Net benefits of a proposal, both monetary and nonmonetary are calculated by determining the excess over those resulting from the baseline supply (i.e., the level of crude expected if none of the proposals are implemented). In discussing the baseline supply, it is assumed that:

1) Canadian crude is not available except in scheduled exports (no exchanges)
2) The price of domestic crude is deregulated
3) Crude is available for Montana at the levels forecasted by DNRC's worst case (table 6, p. 23) if the price remains at world levels
4) Additional crude will become available if the price rises to $7 above world levels
5) Demand for product is at the level given by Bonner and Moore (1978) (Intermediate level, table 10, p. 25)

TABLE 19. ESTIMATED ANNUAL RATE OF INCREASE OF REAL PETROLEUM PRICES

	CRUDE[1]	PRODUCT[2]
1980-1985	3.5 %	1.84%
1985-1990	1.53%	.86%
1990-1995	1.53%	.89%
1995-2000	1.53%	.90%

[1] OPEC price increases have not been included
[2] Assumes that noncrude costs are constant in real terms.

TABLE 20. COMPARISON OF REVISED ESTIMATES OF DEMAND FOR REFINED PRODUCTS AND SUPPLY PROJECTIONS WITH REALLOCATIONS (bpd)

	ADJUSTED BONNER & MOORE ESTIMATES[1]	SUPPLY PROJECTIONS[2]		MAXIMUM SHORTFALL		ADDITIONAL PRODUCT IF CONOCO PIPELINE WERE REVERSED AS NEEDED[3]	
		Intermediate	High	Intermediate	High	Intermediate	High
1980	160,500	237,500	271,000	0	0	——	——
1985	175,000	207,300	241,500	0	0	——	——
1990	189,000	202,180	226,400	0	0	——	——
1995	200,400	193,700	213,900	0	6,700	34,800	——
2000	212,900	186,600	203,600	9,300	26,300	34,800	34,800

CONVERSIONS: 1 barrel = 42 U.S. gallons
1 U.S. gallon = .003785 m^3

[1] As adjusted by DNRC
[2] from table 17
[3] A reversal of the Conoco (Seminoe) Pipeline is possible but not highly probable; for this reason the figures are not included in the projected supply.

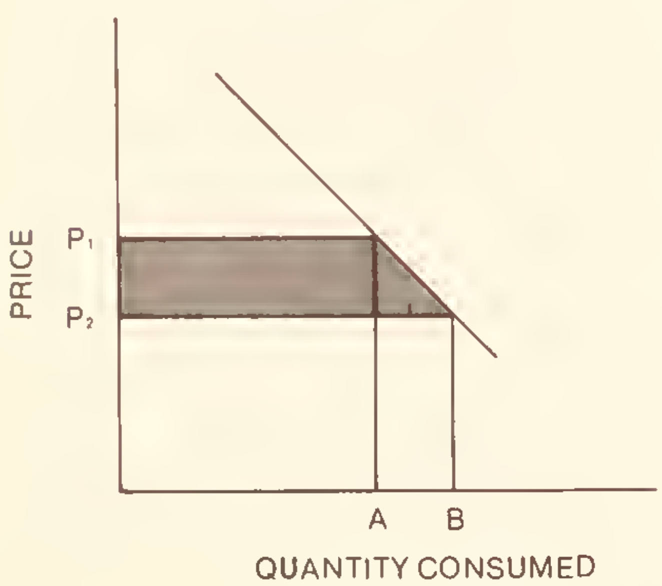
Furthermore, two assumptions are made about the implementation of each proposal to calculate net benefits:

1) The six alternatives are mutually exclusive; no situation is considered in which two or more proposals would be implemented.
2) Implementation of an alternative is the only change from the baseline supply. This means that real prices of other goods and services, consumer preferences, population, and income distribution would remain the same.

Other assumptions used are explained as needed in the analysis.

Monetary net benefits of an alternative include the increase in consumer surplus associated with a delivered cost of crude lower than that in the baseline supply. Consumer surplus is a concept used by economists to indicate the benefit to consumers when they are able to purchase at a lower price. When the price of a product falls, people buy more than before; they also achieve per-unit savings on the amount they would have purchased at the higher price. In figure 8, as price falls from P_1 to P_2 and quantity purchased increases from A to B along the demand curve, the increase in consumer surplus is represented by the shaded area.

FIGURE 8. ADDITION TO CONSUMER SURPLUS THAT WOULD RESULT FROM A FALL IN PRICE



Analysis of the monetary net benefits of an alternative must also include consideration of monetary costs associated with average cost-pricing of electricity used for pumping and with benefits associated with a reduction in unemployment. Additional monetary benefits and costs would be evident only in the Northern Tier Pipeline and the unit train alternatives because they would require construction of facilities in Montana.

The annual monetary net benefit of each proposal over an assumed twenty-year life is calculated using the acquisition cost of crude inherent in the proposal and in the baseline supply. Table 21 gives the present value (in 1980) of monetary net benefits for each proposal, assuming that operation begins in 1981 and that there is a 10 percent social discount rate. Monetary net benefits change as total throughput of the construction alternative changes. Because there has been some speculation about the throughput that could be secured by a new west-to-east pipeline (USDOE 1979), several throughput levels are given.

Nonmonetary net benefits consist of benefits in excess of costs that are not easily translated into monetary values. The major nonmonetary benefit offered by a proposal to Montana is security of crude supply; unmitigated environmental damage is the primary nonmonetary cost.

All of the proposals would contribute to security of crude oil acquisition, and they

TABLE 21. PRESENT VALUE OF MONETARY NET BENEFITS TO MONTANA FOR EACH ALTERNATIVE (1979 DOLLARS)

Alternative		THROUGHPUT (BPD)[1] 48,000	350,000	500,000	Northern Tier as proposed[2]
Northern Tier					
Internal monetary net benefits	(Crude benefit)	n/a	1,387,828,100	1,506,824,083	1,616,170,437
External monetary[3] net benefits	(Taxes paid)	n/a	91,543,200	91,543,200	91,543,200
	(Employment)	n/a	2,822,144	2,822,144	3,334,404
	(Power cost)	n/a	-10,471,680	-28,971,600	-144,470,520
	(Subtotal)		83,893,664	65,393,744	-49,592,916
Monetary net benefits	(Total)	n/a	1,471,721,764	1,572,217,837	1,566,577,521
Trans Mountain					
Internal monetary net benefits	(Crude benefit)	n/a	1,298,519,982	1,430,761,376	n/a
External monetary net benefits		n/a	0	0	n/a
Monetary net benefits	(Total)	n/a	1,298,519,982	1,430,761,376	n/a
Alaska Highway Foothills					
Internal monetary net benefits	(Crude benefit)	n/a	1,042,264,987	1,175,622,310	n/a
External monetary net benefits		n/a	0	0	n/a
Monetary net benefits	(Total)	n/a	1,042,264,987	1,175,627,310	n/a
Kitimat					
Internal monetary net benefits	(Crude benefit)	n/a	1,371,377,000	1,455,097,026	n/a
External monetary net benefits		n/a	0	0	n/a
Monetary net benefits	(Total)	n/a	1,371,377,000	1,455,097,026	n/a
Unit Train					
Internal monetary net benefits	(Crude benefit)	1,064,047,491	n/a	n/a	n/a
External monetary net benefits	(Taxes paid)	631,383	n/a	n/a	n/a
	(Employment)	117,223	n/a	n/a	n/a
	(Subtotal)	748,606	n/a	n/a	n/a
Monetary net benefits	(Total)	1,064,936,097	n/a	n/a	n/a
Nonconstruction					
Internal monetary net benefits	(Crude benefit)		1,607,259,814		
External monetary net benefits			0		
Monetary net benefits	(Total)		1,607,259,814		

[1] Northern Tier, Trans Mountain, Kitimat, and Alaska Highway (Foothills) should be compared at the same throughput level, except as noted below. Unit Train is at 48,000 bpd in all comparisons. Nonconstruction has no meaningful throughput level.

[2] Northern Tier proposes 709,000 bpd initial/933,000 bpd final throughput which should be compared with each of the other alternatives' capacity, 500,000 bpd for Trans Mountain, Kitimat, and Alaska Highway (Foothills).

[3] Northern Tier and Unit Train have external monetary net benefits because they involve construction in Montana. The other alternatives do not involve construction in Montana and have no external monetary net benefits.

all would allow access to the same sources of crude, both foreign and ANS. In times of peace, the pipeline and unit train proposals would be highly secure whether the facility were to cross Canada or the U.S. There are two reasons to believe that a facility built across Canada would be just as secure as one on U.S. soil:

1) The International Pipeline Treaty signed by the U.S. and Canada ("Agreement Concerning Transit Pipelines," U.S. Treaties and International Agreements Series 8720) prohibits either nation from interfering with hydrocarbons moving in transit pipeline to the other nation.
2) Eastern Canada is dependent on crude moving through pipelines on U.S. soil (i.e., the Portland and Lakehead pipelines); therefore, unilateral action by Canada to stop flows to the U.S. would be unlikely.

In times of national or global emergency or embargo, the security benefit of a proposal would be defined by the ability of the facility to deliver crude controlled by the U.S. All the construction proposals would allow delivery of ANS crude, although it would be vulnerable travelling by tanker from Valdez, Alaska. The Alaska Highway Pipeline and the Kitimat Pipeline proposals may each have a security advantage because of their proximity to Valdez. However, if a facility on Canadian soil were more difficult to defend than one on U.S. soil, the NTPC and unit train proposals may have security advantages. Because the nonconstruction alternative relies heavily on Canadian exchanges, security of supply would be reduced. This disadvantage, however, could be offset by the greater reliance of the nonconstruction alternative on Montana and Wyoming crude.

The construction proposals all would allow essentially the same security of supply. Nonconstruction alternatives would not allow as great a level of supply security because they would depend upon Canadian cooperation and a series of exchanges.

Of the alternatives, only the NTPC and unit train proposals would result in the nonmonetary costs of unmitigated environmental damage to Montana. This is because they are the only proposals involving construction and operation inside the state. Both would be likely to cause environmental damage from construction and from oil spills; the NTPC proposal would also necessitate new rights-of-way and additional power generation and transmission requirements.

Results

Since nonmonetary benefits and costs are not easily translated into monetary values, it is not possible to make any definitive statements about the most desirable alternative for Montana based on the benefit/cost analysis. Instead of attempting to estimate the monetary value of the nonmonetary net benefits, hypothetical monetary value can be assigned to the difference between the nonmonetary net benefits of two proposals, allowing a choice to be made between the two proposals.

This hypothetical value is suggested by the difference between the monetary net benefits of the two proposals. For example, if the nonmonetary net benefit from Northern Tier at a throughput of 79,500 m^3/d (500,000 bpd) is valued greater than the nonmonetary net benefit of nonconstruction by at least $35,041,977[2], then Northern Tier would be judged superior to nonconstruction. These hypothetical values are shown for the alternatives in table 22.

TABLE 22. MINIMUM VALUES FOR DIFFERENTIAL NONMONETARY NET BENEFITS WHICH REVERSE PAIRWISE RANKINGS (1979 DOLLARS)

Alternative A is superior to	Alternative B	If the nonmonetary net benefit of A is greater than the nonmonetary net benefit of B by at least: THROUGHPUT (bpd)[1] 350,000	500,000	Construction Alternatives as Proposed[2]
Northern Tier	Nonconstruction	135,538,050	35,041,977	40,682,293
Kitimat	Northern Tier	100,344,764	117,120,811	111,480,495
Trans Mountain	Northern Tier	173,201,782	141,456,461	135,816,145
Unit Train	Northern Tier	406,885,667	507,381,740	501,741,424
Alaska Highway (Foothills)	Northern Tier	429,456,777	396,590,527	390,950,211

[1] Northern Tier, Trans Mountain, Kitimat, and Alaska Highway (Foothills) are compared at the same throughput except as noted below. Unit Train is at 48,000 bpd in all comparisons. Nonconstruction has no meaningful throughput level

[2] Northern Tier proposes 709,000 bpd initial/933,000 bpd final throughput, Trans Mountain, Kitimat, and Alaska Highway are at 500,000 bpd.

TABLE 23. BASELINE ESTIMATES OF MONTANA REFINERY CRUDE SUPPLY (in bpd)

	MONTANA	WYOMING	CANADA	TOTAL
1980	21,400	60,000	24,500	105,900
1981	20,600	60,000	24,500	105,100
1982	19,800	60,000	0	79,800
1983	19,100	60,000	0	79,100
1984	18,400	60,000	0	78,400
1985	17,700	60,000	0	77,700
1990	14,300	60,000	0	74,300
1995	11,600	60,000	0	71,600
2000	9,500	60,000	0	69,500

CONVERSIONS: 1 barrel = 42 U.S. gallons
1 U.S. gallon = .003785 m^3

CONCLUSIONS

In the absence of new pipeline construction, changes in USDOE regulations governing access to local production, or any other attempts to augment crude supplies, Montana refineries could expect the supplies shown in table 23 through the year 2000.

Worst-case supply projections for the Montana refinery service area are based upon assumptions that Montana production will continue to decline, that Montana refineries will have access to no more than their historic share of Montana production, that only 9,500 m^3/d (60,000 bpd) of crude will be available from Wyoming, and that product imports into the service area will remain constant. When these worst-case supply assumptions are combined with the highest demand projections, shortages from 8,000 m^3/d (50,800 bpd) in 1980 to 26,300 m^3/d (165,400 bpd) by the year 2000 result.

Reallocations could increase the availability of crude oil to Montana refineries. These include measures which have historical precedents and are likely to continue, such as Canadian exchanges—which are presently about 7,200 m^3/d (45,000 bpd)—and barges on the Columbia River. Other measures could also become feasible (some may require regulatory change), such as retaining more of Montana's local crude output and reversal of the Conoco product pipeline. These measures would be sufficient to meet the expected level of product demand given likely increases in real product prices.

[2]The monetary net benefit of nonconstruction, which is $1,607,259,814, minus the monetary net benefit of Northern Tier at a throughput of 79,500 m^3/d (500,000 bpd), which is $1,572,217,837 (table 21)

The results of the benefit/cost analysis show that on monetary grounds alone, the reallocation alternative has the greatest present value of net benefits. The next highest alternative is the Northern Tier Pipeline as proposed. The Kitimat Pipeline proposal has the third highest level of monetary net benefits.

The nonmonetary net benefits of each concern must be given a monetary value to determine the order of preference of alternatives. There is no method for making a technical judgment on the likely monetary worth of the relative security benefits or of the environmental costs. Rather these are of necessity social and political judgments.

If the difference between the nonmonetary net benefits of NTPC's proposal and those of reallocation outweighs the monetary net benefit advantage of reallocation, then NTPC's proposal would be the preferred alternative. For the Kitimat Pipeline to be preferred over the Northern Tier Pipeline, the value of the Kitimat proposal's nonmonetary net benefits must be greater than those of NTPC's proposal by more than the monetary net benefit advantage of the Northern Tier Pipeline.

CHAPTER FIVE

ENGINEERING AND GEOTECHNICAL CONCERNS

NTPC has submitted a conceptual design of its oil-transportation system to DNRC; a detailed design cannot be completed until a centerline is selected. DNRC has reviewed the engineering and geotechnology of the proposed project, as well as specific government regulations and industry standards that must or should be met. This chapter discusses potential construction problems, possible solutions to these problems, and the adequacy of the project design as proposed by NTPC. Mitigating measures that could be taken by NTPC to improve the completed pipeline or minimize potential impacts are given at the end of this chapter.

APPLICABLE REGULATIONS, CODES, AND STANDARDS

The majority of federal regulations applying to pipeline systems are included in USDOT's "Minimum Federal Safety Standards for Liquid Pipelines." The index for these standards is given in appendix F.

USDOT and the American Society of Mechanical Engineers have adopted the American National Standard Code (ANSI) for pressure piping. A major section of ANSI applies to piping systems for petroleum transportation. ANSI is frequently revised and represents up-to-date design, construction, and maintenance standards that apply to most conditions normally associated with petroleum pipelines.

It does not specifically address solutions to special problems, but requires design and judgment to be based on sound design principles.

Northern Tier's "Description of the Proposed Action" (DPA) (NTPC 1978a) states that the pipeline system would be built in accordance with the codes, standards, and regulations which are published by the industry organizations and governmental bodies. If these regulations are adhered to, the pipeline system could be safely operated under normal conditions.

PIPELINE DESIGN AND CONSTRUCTION

Pipe and Equipment Specifications

The pipeline would be designed as a "telescoped" line; in other words, the wall thickness of the pipe would be changed to meet the hydraulic pressure requirements at each given location. This is an accepted industry practice which conserves steel while providing the required wall strength where needed.

USDOT regulations require a pipeline system to withstand the total combined stresses that are anticipated. This includes stress resulting from the maximum operating pressure (plus a surge allowance), pipe bending, temperature differentials, and external loadings. For buried pipe, the external loading would include overburden weights and seismic forces. For elevated structures, the loadings would also include wind and ice. Safety factors are included in the design codes. For example, the allowable stress used for design calculations is 72 percent of the minimum yield strength of the pipe (ANSI 1974); this is a safety factor of about 1.4. Stress calculations determine the wall thickness that satisfies the design safety factor; then, a thicker wall pipe is used. The strength of the pipe therefore is greater than that determined by the safety factor calculation.

NTPC's material specifications for the manufacture of pipe as presented in the DPA are more stringent than those required by ANSI. However, NTPC does not propose ultrasonic inspection of all steel plate before the pipe is formed; ultrasonic inspection would provide an additional margin of safety.

The disadvantage of a telescoped pipeline design is the difficulty of ensuring that pipe of the proper size is installed in the correct locations. Rigid quality control and inspection could enforce this requirement.

Complete descriptions and material specifications for equipment other than the pipe are part of the final design and are not yet available for review.

Construction Procedures and Scheduling

The construction of a large-diameter pipeline system would involve the following activities:

1) Taking survey flights over the pipeline route before construction
2) Surveying and staking the centerline
3) Providing access to the pipeline and associated facilities
4) Establishing work camps to house construction personnel (although this is common practice during pipeline construction, NTPC does not propose to use camps)

5) Establishing storage yards for pipe and construction materials and locating material sites such as gravel pits
6) Excavating the pipeline trench
7) Pipe staging—transporting pipe to the trench, welding pipe sections, and wrapping pipe with a protective cover
8) Laying the pipe
9) Constructing pipeline crossings under or over waterways, roads, and railroads
10) Building pump stations and delivery facilities
11) Installing radio-communication towers and low-voltage distribution lines to mainline valves along the pipeline
12) Installing high-voltage power transmission lines to pump stations and delivery facilities
13) Testing the soundness of the pipe (hydrostatic testing)
14) Cleaning up and reclaiming construction sites

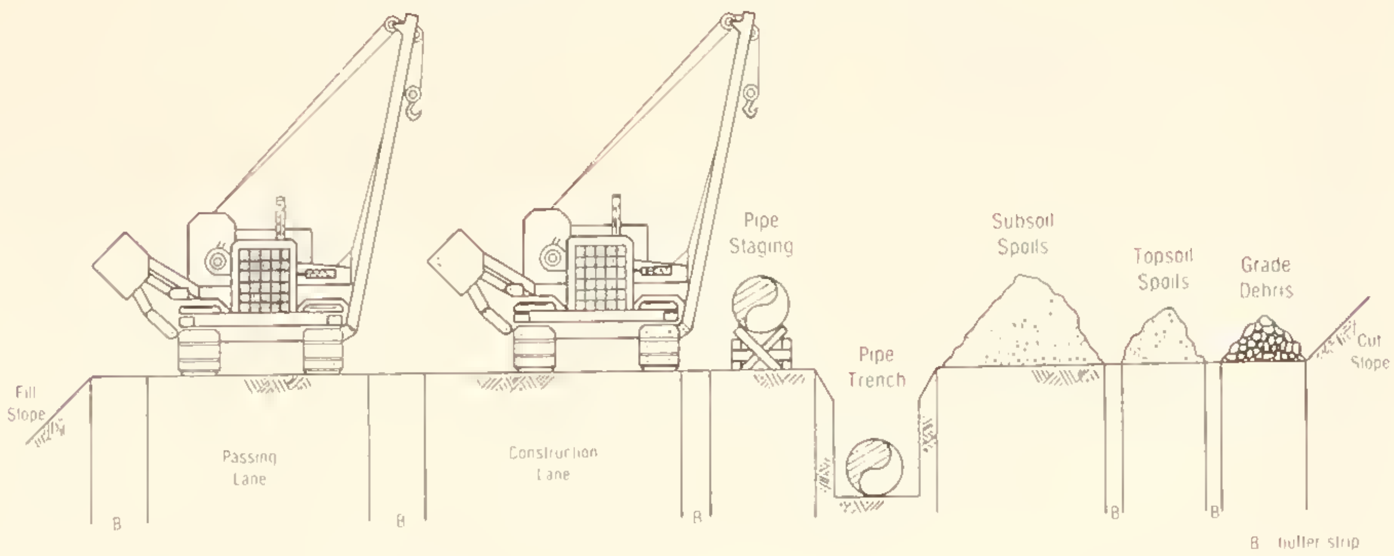
The schedule proposed by NTPC to complete the proposed action is tight for a project of this magnitude. The project could be accomplished by the proposed completion date only if preconstruction planning and project management were above average and if there were no major problems, such as late delivery of materials.

The limited information submitted by NTPC indicates that the construction procedures would comply with accepted industry and federal standards. However, a full evaluation of NTPC's construction procedures is not yet possible because a comprehensive set of construction documents cannot be drafted until after centerline and final plans are available.

Construction Right-of-way

In this report, the term "right-of-way" refers to the strip of land actually used to construct and operate a pipeline system, as opposed to the land for which construction and operation easements were obtained.

FIGURE 10. TYPICAL FEATURES OF A CONSTRUCTION OPERATION FOR A LARGE-DIAMETER UNDERGROUND PIPELINE



Source: Gulf Interstate 1979

The widths of the strips used for construction and operation could be narrower but not wider than the easements. Figure 9 illustrates the difference between the construction easement and right-of-way and the permanent easement and right-of-way, which are discussed on p. 46.

Figure 10 shows a typical construction operation for a large-diameter pipeline; amounts of land required for construction activities are explained in the following discussion. No width dimensions are specified in figure 10, and widths are not necessarily drawn to scale.

Cut and Fill Slopes

In all but the flattest terrain, the right-of-way must be graded to a nearly level surface by cutting into the uphill edge of the right-of-way and filling downslope. The amount of land required for cut and fill slopes differs, depending on the slope of the terrain crossed (as shown in figure 11) and the stability of the material encountered. For example, on a 15 percent slope at least 1.8 m (6 ft) is required for each slope, assuming the need for a 23-m-wide (75-ft-wide) level work pad. This results in a total average construction right-of-way requirement at least 3.6 m (12 ft) greater than that required on flat land. Construction on flat land would obviously take less time than on sideslopes.

Pipeline Trench

The minimum trench width for a 107-cm-diameter (42-in-diameter) pipe, with 91 cm (36 in) between the ground surface and the upper pipe surface is usually approximately 1.5 m (5 ft) at the trench bottom. It can be up to 3 m (10 ft) or more at the top in rock areas or where a backhoe or power shovel is used. A trench dug with a trencher will normally be 1.6 m (5.3 ft) wide, broadening at its top to approximately 2 m (7 ft) (see figure 15, p. 39).

Spoils Storage

A pipeline trench is generally excavated with a large trenching machine which piles spoils to one side of the trench. The piles extend to the edge of the right-of-way in flat terrain, or the beginning of the cut or fill slope in hilly terrain. The amount of land required for spoils storage varies, depending on how topsoil and spoils are removed and stored.

Double Ditching

Where topsoil is present, the trench may be excavated in two stages. First, topsoil is removed and piled away from the trench, leaving a strip of flat ground between the trench and the topsoil piles. The remainder of the trench is then excavated, and subsoil spoils are piled between the trench and the topsoil piles. The segregation of topsoil is especially important on agricultural land, where failure to segregate spoils could permanently reduce cropland productivity for the width of the trench (see "Vegetation and Land Productivity," chapter six, p. 78).

The relative width and height of the two spoils piles would depend on a number of factors, including soil texture and moisture (which determine the angle of repose),

FIGURE 9. CONSTRUCTION AND PERMANENT PIPELINE RIGHTS-OF-WAY AND EASEMENTS

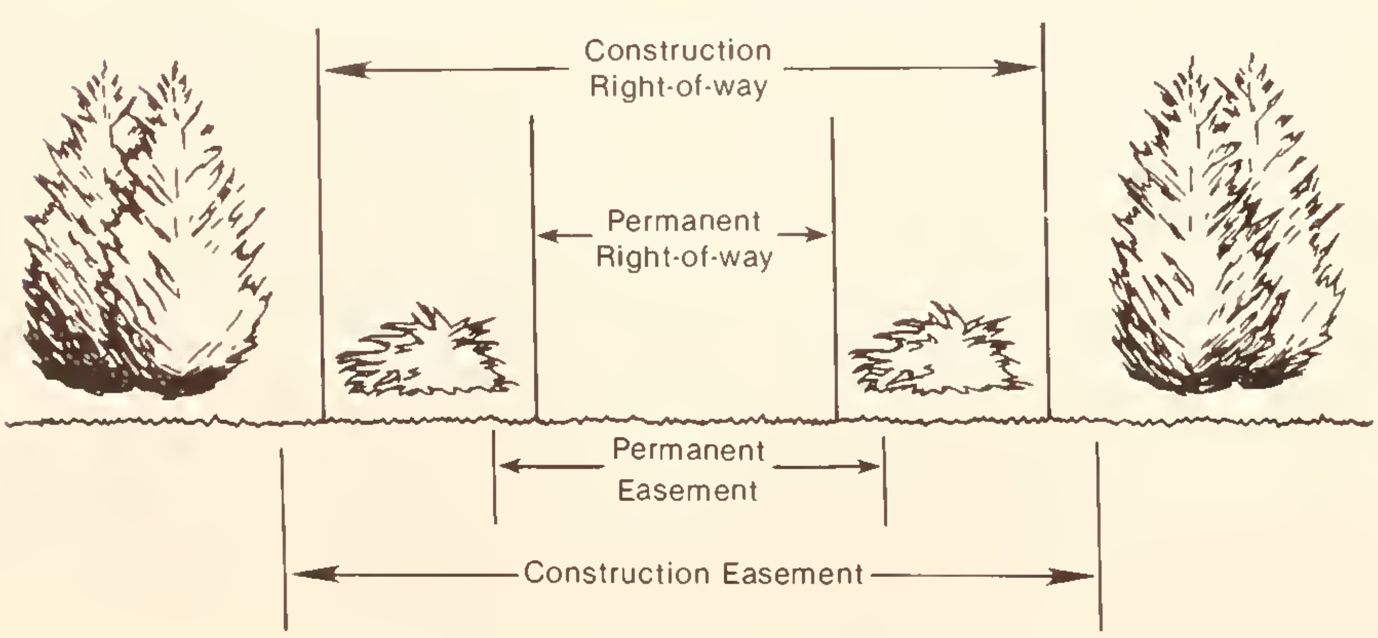
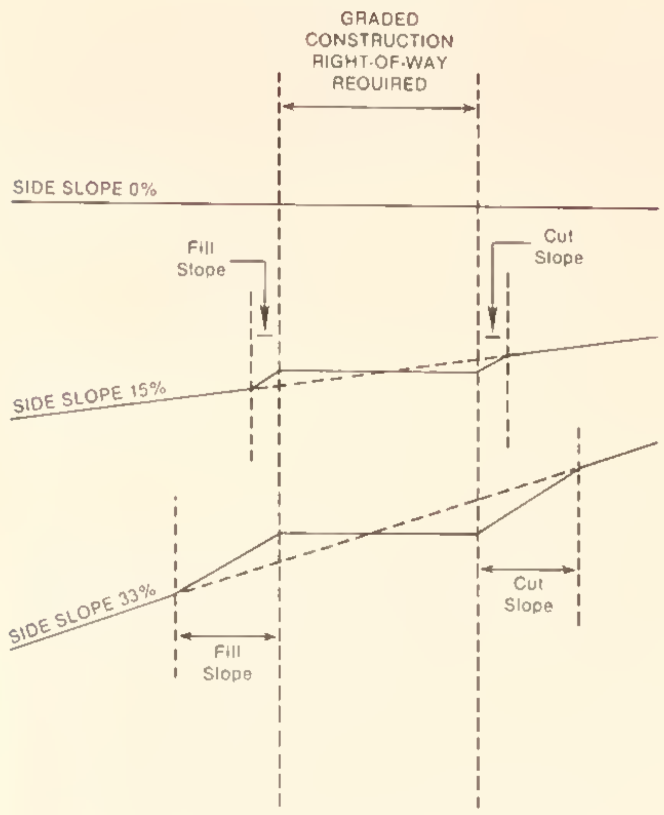


FIGURE 11. COMPARISON OF CUT-AND-FILL SLOPE LAND REQUIREMENTS FOR DIFFERENT SIDESLOPES[1]



[1] A 35° angle of repose is assumed

depth of trenching, depth of topsoil, and the length of time between trenching and backfilling. The combined land width required for subsoil and topsoil piles for NTPC's project would be from 7 to 9 m (25 to 30 ft). Ideally, the subsoil pile and the trench would be separated by a buffer strip approximately 0.6 m (2 ft) wide, as would the two spoils piles; however, these buffer strips are not absolutely necessary, as long as spoils do not spill into the trench and the subspoil and topsoil piles do not substantially overlap. In some cases a third spoils pile up to 1.8 m (6 ft) wide would be located beyond the topsoil pile.

Thus, with double ditching, the ideal distance (in terms of ease of construction) from the edge of the trench to the edge of the graded right-of-way could vary from 12.8 m (42 ft), with three spoils piles and three buffer strips, to 7.6 m (25 ft) with only two spoils piles.

NTPC proposes to use the double-ditching method for the entire length of the pipeline.

Single Ditching

The width of the right-of-way is reduced if only one spoils pile, containing both subsoil and topsoil, is used. However, this does not allow full segregation of topsoil. If the trench were to be dug in a single pass, subsoil and topsoil would be mixed in the spoils site; when this mixture is returned to the trench after the pipe is laid, the productivity of the 2-m-wide (7-ft-wide) strip of land above the pipe could be lowered. This would be a serious impact in highly productive agricultural land, but might not be as serious in rangeland, badlands, or rocky forest land with shallow or poorly developed topsoil (see 'Vegetation and Land Productivity," chapter six).

If topsoil were excavated first, subsoil could then be piled on top of the topsoil. In this way, a fairly high concentration of topsoil would be replaced in the upper portion of the trench, since the bottom layers of the spoils pile would be the last to be backfilled. This method of trenching was employed over most of the underground portions of TAPS.

The width of the spoils pile created by single ditching would vary from 6 to 8 m (20 to 26 ft); a 0.6 -m (2-ft) buffer strip might be required between the spoils pile and the trench.

Off-site Spoils Storage

It is possible to excavate a trench with a backhoe, load the spoils into trucks, haul them off site for temporary storage, and truck them back to the right-of-way for backfill. Because this method would be much slower, more expensive, and more consumptive of fossil fuel than the methods discussed above, it would only be practical over short distances and in unusual circumstances, such as constricted areas in the bottom of a steep, narrow canyon. Spoils storage would be a problem; a fairly large storage area outside the right-of-way would be required, resulting in a number of off-site impacts.

Pipe Staging

Pipeline sections are transported to the right-of-way, positioned parallel to the trench, welded together, and the welds X-ray inspected. The welds are then wrapped with protective coatings. The pipe is coated before being transported to the right-of-way. Staging generally requires a 2.4- to 2.7-m-wide (8- to 9-ft-wide) strip adjacent to the trench. The width of this strip could be reduced by welding pipe sections off-site, transporting them to the right-of-way, and making tie-in welds. However, this is so slow and expensive it could be done only with short sections of pipe in restricted circumstances.

Construction Traffic Lane

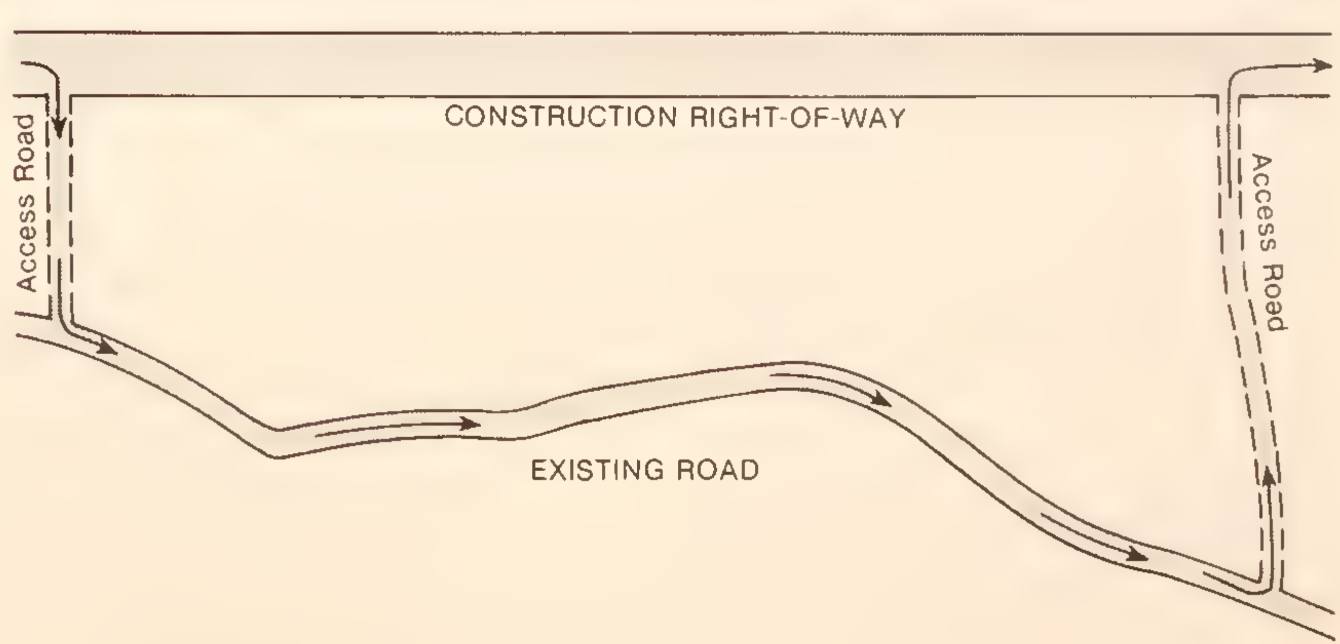
A traffic lane wide enough to allow movement of heavy machinery used for pipe hauling, welding, coating, and laying, must be adjacent to the pipe-staging area. Generally, sideboom tractors are the widest piece of machinery to use this lane. With the sideboom extended, the tractors are roughly 5.4-m (18-ft wide); thus, 5.4 m (18 ft) would be the minimum width required. NTPC proposes a 1.8-m-wide (6-ft-wide) buffer strip between the traffic lane and the pipe-staging area. While this would make construction easier, it would not be absolutely necessary because a 2.4-m (8-ft) pipe-staging area would automatically include 0.3 to 0.6 m (1 to 2 ft) between the pipe and the traffic lane. Thus, 5.4 m (18 ft) would be a reasonable width.

Passing Lane

All stages of pipeline construction can be accomplished using a single traffic lane; however, single-file operation would be required for construction. This would increase construction time and hence costs. For example, ditching would have to be completed before laying out the pipe, and pipe would have to be laid out before the lineup and welding could begin. Therefore, a passing lane is necessary for efficient construction. For optimum efficiency, the passing lane would be located immediately adjacent to the traffic lane. A minimum lane width of 3.6 m (12 ft) (the width of a sideboom tractor with sideboom retracted) would allow tractors to squeeze by one another. Passing would be easier with a 0.6- to 1.2-m-wide (2- to 4-ft-wide) buffer strip between the construction and passing lanes but this would not be absolutely necessary. In timbered areas, a second buffer strip about 0.9 m (3 ft) wide between the passing land and the right-of-way edge would expedite traffic movement, but would not be necessary if a cut or fill slope were present.

An existing road, such as a logging or county road, that parallels the right-of-way could be used as a passing lane rather than constructing one within the right-of-way (figure 12). An existing road with frequent access roads could easily serve as a passing lane for passenger vehicles, although not necessarily for construction equipment

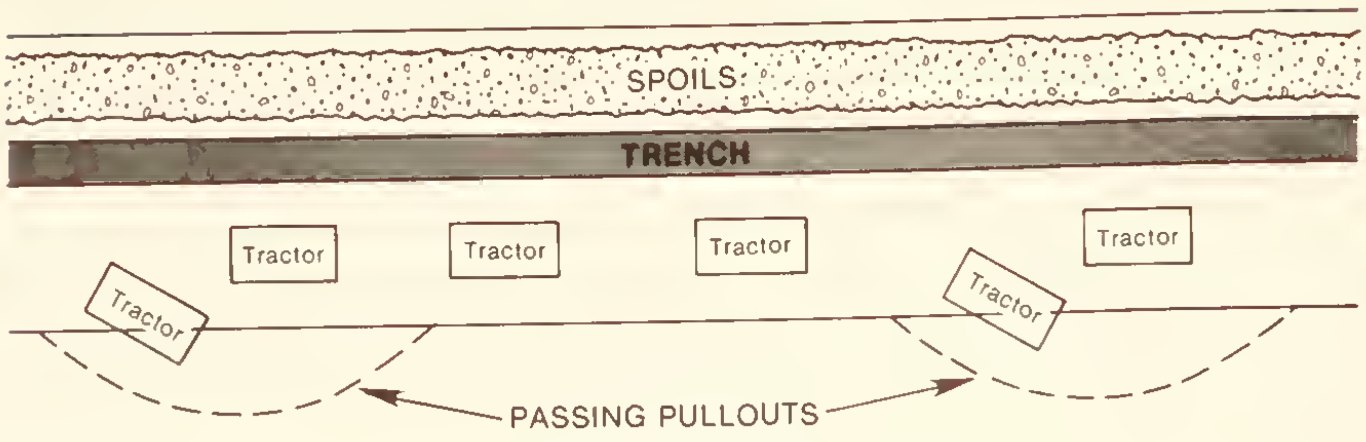
FIGURE 12. POSSIBLE USE OF AN EXISTING ROAD NEAR CONSTRUCTION RIGHT-OF-WAY FOR A PASSING LANE



(which would remain on the construction right-of-way). Thus, use of existing roads would not be as convenient as construction of a passing lane and would slow construction.

It is also possible to establish frequent pullouts along the construction right-of-way (figure 13). This would result in an irregularly shaped edge that, in certain timbered areas, could reduce the visual impact and increase the quality of habitat for some wildlife species. These pullouts would be a less efficient means for allowing passing than construction of a passing lane.

FIGURE 13. POSSIBLE USE OF PULLOUTS FOR PASSING DURING PIPELINE CONSTRUCTION



Construction Right-of-way Widths

NTPC has proposed a 27-m (90-ft) width for the construction right-of-way. Considerable latitude is possible in construction right-of-way width. Wider spans are preferable in terms of construction ease, but narrower widths result in less disturbance of land, wildlife, and other natural resources. The following discussion of the advantages, disadvantages, and practicality of different right-of-way widths refers **only** to the graded portion of the construction right-of-way excluding river crossings. Table 24 tabulates the space alloted each construction activitiy within the different right-of-way widths.

Where steep terrain is crossed, cut and fill slopes of undetermined width would be added to either edge of the right-of-way. The necessary width of these slopes would depend on the slope of the land. Relatively little cut and fill would be required where a right-of-way goes directly up or down a hill, whereas sidehill construction would require extensive cut and fill and hence a wider overall construction right-of-way.

27-m (90-ft) Right-of-way

A construction right-of-way 27-m (90-ft) wide is generally adequate for speedy cross-country construction, as it allows adequate room for equipment to pass and for spoils piles. Figures 14 and 15 show two ways that the minimum widths required for the many construction operations could be allocated in a 27-m-wide (90-ft-wide) right-of-way.

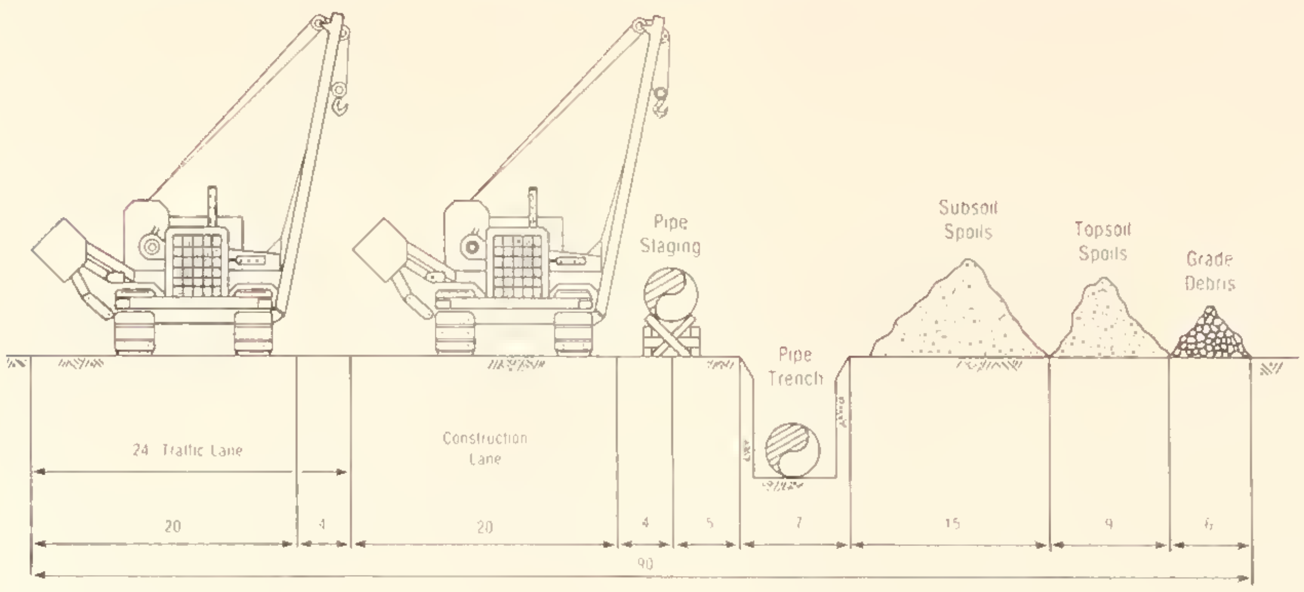
TABLE 24. LAND APPORTIONED TO CONSTRUCTION OPERATIONS FOR VARIOUS RIGHT-OF-WAY WIDTHS[1]

	CUT OR FILL SLOPE (not included in total)	PASSING LANE BUFFER	PASSING LANE	BETWEEN LANE BUFFER	CONSTRUCTION TRAFFIC LANE	PIPE BUFFER	PIPE STAGING	TRENCH	TRENCH SPOILS CLEARANCE	SUBSOIL SPOILS	CLEARANCE BETWEEN SPOILS PILES	TOPSOIL SPOILS	GRADE DEBRIS	CUT OR FILL SLOPE (not included in total)	TOTAL (for graded R/W only)
Absolute minimum for conventional construction with passing lane, topsoil segregation	0	0	12 ft	2 ft	18 ft	0	8 ft	7 ft	0	15 ft	0	9 ft	0	0	71 ft
27 m (90 ft) R/W, flat terrain (NTPC Proposed)	variable	3 ft	12 ft	2 ft	18 ft	6 ft	8 ft	7 ft	2 ft	20 ft	2 ft	10 ft	0	variable	90 ft
27 m (90 ft) R/W, flat terrain, agricultural land	0	0	20 ft	4 ft	20 ft	0	9 ft	7 ft	0	15 ft	0	9 ft	6 ft	0	90 ft
27 m (90 ft) R/W, 15% slope, cut and fill, agricultural land—spoils uphill	6 ft	0	18 ft	2 ft	20 ft	0	9 ft	7 ft	0	15 ft	0	10 ft	0	6 ft	81 ft
23 m (75 ft) R/W, flat terrain no topsoil segregation	0	0	16 ft	4 ft	20 ft	0	9 ft	7 ft	0	19 ft	0	0	0	0	75 ft
23 m (75 ft) 15% slope, cut and fill, no topsoil segregation, spoils uphill	4 ft	0	16 ft	0	16 ft	0	9 ft	7 ft	0	19 ft	0	0	0	4 ft	67 ft
20 m (65 ft)	0	0	0	0	20 ft	0	9 ft	7 ft	0	15 ft	0	9 ft	0	0	20 ft
16 m (54 ft) R/W, flat terrain, no topsoil segregation	0	0	0	0	20 ft	0	9 ft	7 ft	0	18 ft	0	0	0	0	54 ft

Conversion 1 ft = .3048 m

[1] Clearance and buffer zones are not included in right-of-way

FIGURE 14. ESTIMATED LAND REQUIREMENTS FOR A 27-m (90-ft) CONSTRUCTION RIGHT-OF-WAY THROUGH FLAT TERRAIN WITH DOUBLE DITCHING AS DESIGNED BY GULF INTERSTATE FOR DNRC



CONVERSION 1 ft = 3048 m

23-m (75-ft) Right-of-way

On flat terrain, it would be possible to squeeze a construction spread into a 23-m-wide (75-ft-wide) right-of-way, including a passing lane and segregated topsoil and subsoil piles. By combining the lowest estimated width requirements of each construction feature for a 27-m-wide (90-ft-wide) right-of-way (see table 24), it would be possible for construction to take place on a right-of-way as narrow as 22 m (71 ft) without sacrificing topsoil segregation. If topsoil were not segregated, only 6 m (20 ft) would be required for spoils sites, and a 23-m-wide (75-ft-wide) right-of-way would easily suffice. Where an existing road could be used as a passing lane, a 23-m-wide (75-ft-wide) right-of-way would be adequate. The primary disadvantages of this width would be the hindrance of movement of machinery and the need to take greater care during construction.

20-m (65-ft) Right-of-way

To confine construction to a 20-m-wide (65-ft-wide) right-of-way, either the passing lane or topsoil segregation would have to be eliminated. Table 24 shows how a 18-m (60-ft) width could meet the minimum land requirements for all construction features except the passing lane.

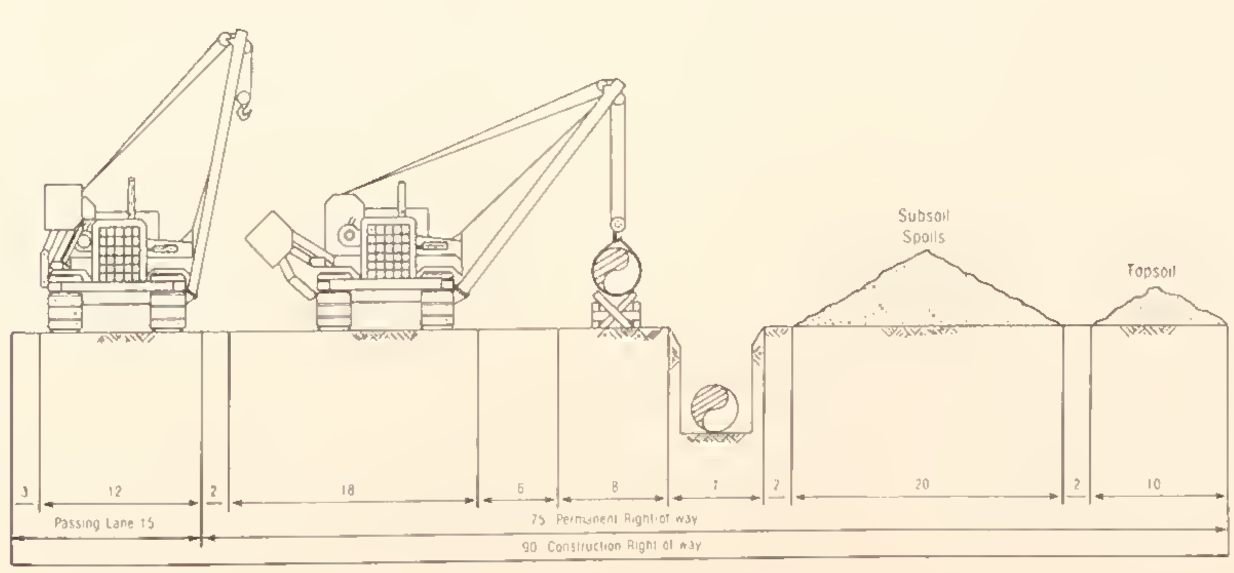
16-m (54-ft) Right-of-way

If both the passing lane and topsoil segregation were eliminated, it would be possible to confine construction to a 16-m-wide (54-ft-wide) right-of-way. This would be the minimum right-of-way width that would allow conventional construction techniques.

9-m (30-ft) Right-of-way

Any right-of-way less than 16 m (54 ft) would require special construction techniques and equipment, and would therefore be much more expensive and less efficient than construction in the wider rights-of-way. Over short segments of a pipeline, a right-of-way as narrow as 9 m (30 ft) would suffice if: (1) ditch spoils were removed from the right-of-way to a storage site, (2) segments of pipe were welded and bent away from the restricted right-of-way and then put into place, and (3) single-file operations were employed.

FIGURE 15. ESTIMATED LAND REQUIREMENTS FOR A 27-m (90-ft) CONSTRUCTION RIGHT-OF-WAY THROUGH FLAT TERRAIN WITH DOUBLE DITCHING AS DESIGNED BY NTPC



Conversion: 1 ft = .3048 m
Source: NTPC 1979

Crossings

Road Crossings

NTPC proposes to trench road crossings when possible. Generally the trench would be excavated on either side of the road, and the pipe laid and welded. A section of pipe for the road crossing would then be readied. The trench would be excavated across the road, the pipe welded and lowered into the trench, and the road backfilled and restored to original condition. At the discretion of the owner of the road, traffic flow could be maintained by detours or blocked during this operation for two or three days.

When no road surface disruption is allowed, the crossings would be made by drilling under the road and pulling the pipe through a casing. This technique requires staging areas on both sides of the road for drilling, pipe welding, and associated equipment. Traffic flow would not be interrupted during installation of drilled crossings.

Where the pipeline would be constructed parallel to a highway or road, construction could slow traffic flow, possibly necessitate detours, and probably damage the road surface. Restoration of the road is normally the responsibility of the construction company and would increase pipeline construction costs.

Interstate Highway Crossings

Generally, crossings of interstate highways would be drilled and no traffic disruption should occur. It would be considerably more expensive to cross a four-lane interstate with a median strip than to cross a two-lane highway.

Railroad Crossings

The design of the pipeline crossing under a railroad would be basically the same as the one for interstate highways, except that the external loading on the pipeline from rail traffic would be considerably greater than that associated with highway traffic. In addition to ANSI and USDOT regulations, there are railroad industry standards, to which NTPC must adhere. Earth padding, timbers, or other protection would be required where equipment crosses the railroad to prevent damage to the tracks and track bed.

Constructing a pipeline on the bed of an operating railroad would be extremely costly, would result in the complete shutdown of rail traffic, and could damage the bed and track. Generally railroad beds are narrow and have steep cut and fill slopes. The

existing track may have to be pulled up, the bed graded to make room for construction, the pipe laid and trench backfilled, and the bed and track replaced. Abandoned railroad beds could be used, but the increased amount of grading required would make this option generally more expensive than cross-country construction.

Operating railroads paralleling or crossing the pipeline could be used to transport pipe to the staging areas. Use depends on NTPC's construction plan, on convenience of loading and unloading the railroad cars, and on shipping costs, among other factors.

Other Utility Crossings

NTPC's proposed crossings of utilities and other pipelines would be designed and installed in accordance with applicable codes, accepted industry practices, and the requirements of the owners of each facility crossed. Cathodic protection requirements for the proposed pipeline and the facility crossed would be jointly designed by the respective owners.

Northern Tier construction crews would encounter many overhead transmission and telephone lines. Although it requires caution, crossing under these lines is not usually hazardous. Most equipment would be able to cross under telephone lines. Any equipment too tall to pass under a line could be routed around it or the line could be temporarily raised enough to permit passage.

An electric current can be induced in the pipe when a pipeline closely parallels a high-voltage powerline (either buried or overhead), possibly creating the potential for dangerous electric shock and certainly creating conditions in the pipe for increased corrosion if inadequate corrosion-prevention measures are not taken. This could be mitigated by special grounding equipment.

The responsible agencies would be asked to mark the location of any underground power, telephone, gas, water, oil, and sewer lines crossing the route. Because locating equipment is generally accurate enough to locate lines within 0.6 or 0.9 m (2 or 3 ft), breakage can usually be avoided if precautions are taken. There could be some breakage of lines (such as power, telephone, or water lines to individual homes) for which the locations are not known at the time of excavation. Service would be disrupted until the maintaining agency could make repairs. Generally, other utility crossings would be avoided as much as possible.

Sharing trenches with other lines would be avoided because of the increased chance of damage to all lines when a problem develops with one.

Stream Crossings

There are four types of stream crossings: trenched, directionally drilled, horizontally drilled, and aerial. NTPC has proposed trenching all river crossings, but is considering the other methods (NTPC 1979b).

Potential washout of the pipe and subsequent damage are the primary risks to buried pipeline crossings. For protection against washout damage, NTPC has proposed to bury the pipe a minimum of 1.2 m (4 ft) below the maximum predicted scour depth of each river or stream.

NTPC's method for calculating scour depths, which is on file at DNRC and available for public review, was reviewed and cross-checked against similar calculations done for this EIS by DNRC. NTPC's approach is satisfactory and provides a reasonable estimate of scour depth, considering the data base used to develop the formulas. Site-specific calculation is highly dependent on the selection of the streambed coefficient. To ensure an accurate calculation, NTPC's site-specific streambed coefficients could be compared to DNRC's coefficients before a final design scour depth is selected.

Trenched Pipeline Crossings. Most pipeline river crossings in the U.S. have been installed by trenching. Using this method, a trench is excavated in the streambed, the pipe laid, and the trench filled. Trenched pipeline crossings may need a wider-than-normal right-of-way for temporary storage of excavated ditch spoil. The pipe would have to be strung, bent, welded, concrete-coated, and prehydrotested before any instream work could begin. To form the crossing ditch, the streambed would be excavated with backhoes, draglines, or dredges, depending on the width of the stream, the streamflow, and streambed material. The ditch would have to be deep enough so that the pipe would be at least 1.2 m (4 ft) below the maximum predicted scour depth. After excavation, the pipe—which may be in sections over 100 m (328 ft) long—would be pulled into place with rollers, floats, pulling winches, and sideboom tractors. After the pipe is in place, the ditch must be backfilled, the river banks restored, and the area cleaned up and reclaimed.

The ideal section of stream for a trenched pipeline crossing would have gently sloping approaches and channel banks, shallow channel depth, narrow flood plain width, and minimum potential for streambed scour or bank erosion. Ideally, the flood plain and streambed materials should be those which are easily excavated, but which have minimum potential for caving or sloughing; hard bedrock is not desirable.

If a crossing is beneath the maximum scour depth of the river, there is little probability of its failing. However, if there is a pipeline failure at a crossing, the pipe would have to be either abandoned or reexcavated for repair and a second pipe installed. This would have to be done even if it were a small leak. If the pipe were placed in a casing, the risk of oil entering the river would be reduced.

NTPC's design for trenched stream crossings provides for extra thickness of pipe, buoyancy control, location of the sag bends a minimum of 4.6 m (15 ft) into the banks beyond the predicted limit of bank erosion, and a minimum burial depth of 1.2 m (4 ft) below the calculated scour level. All of these provisions increase the design safety factor above that required by ANSI regulations.

Directionally Drilled Pipeline Crossings. In this method, a specially designed drill arcs a tunnel under the riverbed. As the drilling proceeds, the cutting head pulls an outer casing pipe through the tunnel. This outer casing protects the actual oil pipeline which is pulled through the casing to complete the installation. Directionally-drilled crossings do not disturb the flow or stream bottom, do not require localized bank destruction, and do not disturb aquatic life. They do not interrupt boat traffic and have almost no visual impact. Since the banks are not disturbed, there is no need for riprap or other amoring (Congram 1978). Before drilling, it is necessary to make a subsurface geologic profile by taking core samples from the riverbed; this generates a small amount of sediment. There can also be problems with spills of machinery oil and used drilling "mud" at the staging area.

Directional drilling is a new technique for large-diameter pipelines. Most of the crossings have been in Gulf Coast swamps in sandy or clayey soils. To date there have been no directionally drilled river crossings in mountainous areas. Because there is no efficient way to drill through mixed soil and bedrock deposits, a homogeneous substrate is required. The technique is impractical for small streams because the drill cannot turn at a sharp angle to return to the surface.

Horizontally Drilled Crossings. This method requires excavation of vertical shafts about 9 m (30 ft) on either side of the stream. A horizontal shaft going under the streambed (at least 1.2 m (4.0 ft) below maximum scour depth) is drilled to connect the vertical shafts. The pipe is routed down the shafts through a protective casing.

The advantages of this method are the same as for directionally drilled crossings: no stream or bank disturbance and little visual impact. Any leaks occurring would generally show up in the shafts on either side of the waterway before the stream was contaminated. There would be substantial land disturbance because of pipe welding, testing, storage of excavated materials, and dewatering operations. Ground water is usually encountered during excavation of the shafts. This would have to be pumped out and stored in a settling pond before being discharged back into the stream. Horizontal drilling would be more expensive than trenching, but is a conventional technique. It could be used on small, steep-banked streams where directional drilling was not feasible.

Aerial Pipeline Crossings. Aerial crossings of rivers avoid most instream disturbances. There are three main methods for aerial crossings: (1) constructing a free-span suspension bridge, (2) constructing a pier crossing (pipe bridge), and (3) installing the pipeline on an existing highway or railroad bridge. When constructing a suspension bridge, large towers are built on each side of the river. The pipe is floated across the river and raised into place. The pipeline is supported by a system of steel cables attached to concrete anchors buried near the suspension towers (Deason 1975, Appelt (1974). An aerial per crossing is basically the same as a regular highway or railroad bridge, but designed to support one or more pipelines. A pier crossing can cross a river in one span or it can be built with instream pilings and multiple spans, depending on the width of the river. The third aerial crossing method is to fasten the new pipeline to an existing railroad or highway bridge. If the bridge is not capable of bearing the extra weight, it can be strengthened.

The stream cross section necessary for aerial crossings is different from that required for buried crossings. Ideally, an aerial crossing requires high and steep channel banks, narrow channel width, and no flood plain. To support the structure properly, the banks should have high load-bearing capacity; bedrock at a shallow depth is desirable. Minimal instream work is necessary, but the banks must be shaped to allow equipment and the pipe to be moved down to the water's edge. On a large river it may be necessary to construct a support in the river channel. Erection of cofferdams or sheet pilings and some instream work would then be required.

Aerial crossings can be constructed with a casing around the oil pipe. This would provide added protection against damage from external sources and could prevent leakage spilling directly into the stream by draining oil to either side. If catchment basins were constructed at the ends of the casing pipe (where terrain permitted), an oil leak could be effectively contained. However, leaks in the pipe would be harder to repair if a casing were used (but generally easier than for all buried techniques), and the crossing would be considerably more expensive. Catchment basins would require regular maintenance.

Aerial crossings have been in operation for twenty-five years and no failures have occurred to date (NTPC 1979b). Design for aerial crossings must consider earthquakes, floods, and wind and ice loadings, as well as usual hydraulic design criteria.

Conclusions. To choose one stream-crossing method as universally best overlooks the complexity of the necessary geologic and environmental evaluations needed for stream crossings. With proper design and construction, all of the crossing methods are satisfactory from the standpoint of engineering reliability. (See related discussion in "Pipe Protection," p. 43.) Buried crossings, however, are less likely to leak than aerial crossings. Impacts of river-crossing construction are discussed in "Aquatic Life and Habitats," chapter six, p. 68. The crossing methods are compared in table 25.

Canal Crossings

There are several ways of crossing canals, depending on canal size and the time of year. For trenched crossings of irrigation canals, if construction coincides with the nonirrigation season, canals could be temporarily closed with no adverse effects. Pipe-laying would then proceed normally. If water flow must be maintained, the crossing could be drilled or a temporary pipe could be laid to carry irrigation water over the pipe trench during construction. Canal crossings could be done in about two days and could be scheduled to result in minimum disruption of irrigation practices.

NTPC proposes to use drilled or aerial crossings, if waterways cannot be trenched. There would be no disruption of the water flow with either method. The cost of aerial construction is approximately equal to that of trenched crossings.

TABLE 25. SUMMARY OF RIVER CROSSING METHODS

	ADVANTAGES	DISADVANTAGES
Buried—Trenched	No long-term visual impact except where streambanks are riprapped Low risk of oil spills—below flood scour depth	Severe disturbance of streambed and banks during construction Siltation downstream during construction Broad rivers require dredging or use of a haul line during construction; cannot be repaired without excavation into streambeds
Buried—Directionally Drilled	No disturbance of streambed or banks Low risk of oil spills—double pipe, deep below river, could be repaired without excavation into streambed No visual impact	Angle of drilling limits type of stream sections that can be crossed High cost—approximately 1.5 times trench crossing Can be used only in homogeneous substrate Drilling technology not proven, especially for hard rock
Buried—Horizontally Drilled	No disturbance of streambed or banks Low risk of oil spills—double pipe, deep below river, could be repaired without excavation into streambed No visual impact Can be used at small streams in some cases	High cost Possible dewatering of stream during drilling operation
Aerial—Suspension Bridge	No damage to river bottom Easy access for repair in case of damage or oil spill (unless double piped) Easy leak detection	High risk of oil spills relative to buried crossings—vulnerable to damage High visual impact (requires towers as high as 90 m (300 ft)) Minor to moderate damage to river banks
Aerial—Pier Crossing	Only minor damage to streambed and banks, given proper construction Easy access Easy leak detection	High visual impact Vulnerable to damage
Aerial—Use of Existing Bridge	Essentially no new disturbance of streambed and banks if structure needs no major modification Easy leak detection	Need to modify bridge for pipe; may need to strengthen bridge Vulnerable to damage Slight additional visual impact

Earthquake Hazards

A review of historical seismicity, geological setting, and available information on earthquake damage to pipelines was done for this EIS. **Northern Tier Report No. 4** provides the basis for identifying the areas of probable seismic disturbance, projecting the frequency of such disturbance, and determining the maximum level of disturbance that must be considered for safe design of the oil transportation system.

All known earthquake hazards to the proposed pipeline are in western Montana, which lies in an active earthquake zone known as the Intermountain Seismic Belt (see map 3, p. 44). Several earthquakes of Richter magnitude 6 and one of magnitude 7 have been recorded. Because of this past activity, future similar-sized disturbances can be expected.

Probability analysis of the seismic history of areas near or crossed by the pipeline routes suggests that in the Three Forks region an earthquake of Richter magnitude 6 can be expected every 73 years and of magnitude 7 every 472 years. A magnitude-6 quake can be expected every 70 years and a magnitude-7 quake every 364 years in the Helena-Lincoln region (which includes the Townsend area). These areas require special investigation, and, possibly, earthquake-resistant design would be necessary. Special investigation and appropriate design would also be necessary in hazardous areas such as the Nevada Valley and along the Ninemile Fault west of Missoula where there has been recent low-level seismic activity, and possibly at the crossing of the Hope Fault east of Thompson Falls. An earthquake of magnitude 7 has not yet been recorded in any of these areas.

Analysis of earthquake activity during approximately the past one hundred years indicates that this time interval may not be long enough to fully represent the actual potential for strong earthquakes. Therefore, given the project lifetime of twenty years, a Richter magnitude of 6.5 to 7.0 would be a "credible" or "design" earthquake. Analysis of the available information indicates that there is less than one chance in ten that the magnitude 6.5 to 7.0 level will be exceeded during the twenty-year period.

Ground disturbances from magnitude 6.5 to 7.0 quakes can be large in the immediate vicinity. Estimates of maximum acceleration levels from such events range from about 0.38 to 0.67 g at ground surface immediately above the focus of the earthquake. (One g is equivalent to the gravitational acceleration at the earth's surface.) The acceleration levels are strongly dependent upon subsurface conditions, and actual measurements from smaller Montana quakes show that the levels may be on the order of one-quarter to one-third of the estimated values. For this reason investigations of subsurface conditions would allow an appropriate disturbance-level risk to be incorporated in the design where pipeline crossings or structure location are near zones of seismic activity.

Another earthquake-related risk to the pipeline system would be fault movement that may differentially shear the soil or rock around the pipe or other under-the-surface structures. Similar effects could occur from earthquake-induced slope failures and liquefaction of sensitive soils. Faults that have shown Recent (approximately last ten thousand years) movements causing rupture of the ground surface have not been identified along any of the pipeline routes, in spite of the known seismic history. The routes do, however, cross faults that have moved in the not-too-distant geologic past, and these require special investigation to determine the need for special design. These faults include those in the Nevada Creek, Helena, Townsend, and Ninemile valleys, and the Hope Fault. Others may be found during studies proposed by NTPC. The Hope Fault, near Thompson Falls, is possibly inactive, but evidence for this is inconclusive. Slope-failure risk would have to be examined on site after a final route is selected. Where the potential for slope failure is present, special construction and design features should be incorporated.

Liquefaction risks are expected only in and near river crossings, where silt and sand deposits are present in a water-saturated environment. NTPC calculations show that, as designed, the pipe would be strong enough to support itself, if landslides or fault movement were to remove the soil or rocks from around the pipe for distances up to 30 m (100 ft). Spans of 120 to 150 m (400 to 500 ft) of fully loaded pipe can be tolerated in water without reaching the yield strength of the pipe because of the buoyant support of the fluid (NTPC 1979b). Even longer spans can be tolerated in liquefied soils because the soil-water slurry has a greater density (i.e., more buoyant support is present) than air. DNRC concludes that spans of pipeline exceeding these lengths in a fluid or liquefied zone would probably not occur. Moreover, if liquefaction did occur near river crossings, the risk of the pipe breaking would be further reduced because thicker and therefore stronger pipe would be used in stream and river bottom areas.

DNRC reviewed the limited available information regarding damage to crude oil pipelines from earthquake disturbance. Evidence was found that pipelines can withstand earthquake disturbance when designed for disturbance magnitudes on the order of the recommended "credible" earthquake; that is, one with a Richter magnitude of 6.5 to 7.0. The review showed that significant damage had occurred to above-ground facilities, power supplies for pump stations, and other pipe sytems that were not well designed. Thus, the chance of damage to the above-ground facilities of the Northern Tier project would probably be greater than to the buried pipe. Design measures that could be incorporated into these facilities to reduce earthquake damage include structural modifications to buildings, energy-absorbing foundations, and fail-safe shut-down features in the control system.

NTPC has proposed a detailed seismic risk evaluation and development of seismic design criteria (see appendix E).

Soils and Terrain

Construction methods, costs, and efficiency would be influenced by the terrain and the type of soil material that must be handled to install the pipeline. For example, soil material which is difficult to excavate would increase construction costs and efficiency. Similarly, the greater the cross or longitudinal slope is, the more difficult and costly construction would be.

DNRC inventoried the engineering geology on all proposed routes. This inventory has not identified any critical problems, other than landslide areas (most of which can be avoided) and a number of areas with hard bedrock that would need blasting to excavate the trench (see map 4, p. 48). Excavation in the mountainous part of Montana would require extensive ripping or blasting; for instance, 476 km (296 mi) of NTPC's proposed route would require this type of construction. Special equipment such as drills, rippers, and associated support equipment would be needed. Steep slopes may require considerable bench cutting or procedures for winching the equipment up or down hillsides. To reach burial depth in loose soil, extensive excavation would be necessary since the banks would not stand vertically and must be sloped back at least to the angle of repose to provide stability. If potential landslide areas are crossed, it would be necessary to construct stabilization features such as unloading by bench cuts above the pipe, underdrains, or toe buttressing. To maintain the projected schedule, construction through these conditions would require management coordination, and extra equipment and crews may be necessary to perform the work involved. In some of the areas, such as steep slopes and possible slide areas, it may be necessary to temporarily have wider rights-of-way to accommodate construction.

Avoidance of hard rock, unstable soils, possible slope-failure areas, and extreme slope conditions during centerline selection would increase construction efficiency. Mitigating measures for controlling the side effects of the construction—such as accelerated slope failure and erosion, and the related impacts on vegetation, land use, and water quality—could be instituted (see chapter six).

Pipe Protection

Damage from Accidents and Vandalism

Pipe protection is generally ensured by burying the pipe over its entire length. Burial depths can vary from 0.5 m (1.5 ft) to more than 1.2 m (4 ft) of ground cover, depending upon ground conditions. For NTPC's proposed pipeline, cover in most areas would be 0.9 m (3 ft).

Exposed pipe at aerial crossings of rivers would be vulnerable to accidental damage from planes, boats, and construction equipment. Most accidents could be prevented by sufficient clearance for river traffic and by security fencing or other means of denying access to the support structures. Although the crossings may be struck by airplanes, this hazard could be reduced by marking the pipe or lighting the structures exceeding the minimum height requirements of the Federal Aviation Administration. Vandalism, such as rifle fire, is generally not serious, but could be reduced by inserting the oil pipeline into a protective casing. The double-wall pipe design would also provide protection from leaks which may result from accidental damage.

Although the right-of-way would be cleared in forested or shrubby areas, and therefore

TAPS Photo by Charles Kay

PUMP BUILDING AFTER EXPLOSION AND FIRE

visible, accidental damage to buried pipe may still result from excavations with bulldozers, trenchers, backhoes, or drilling equipment. Damage may vary from minor disruption of the surface coating to small punctures. It would take a large piece of equipment to cause damage more serious than a small hole. USDOT regulations require signs warning of the buried pipe at all road and railroad crossings. Additional markers could be posted and warning tape buried above the pipe to reduce construction accidents.

Above-ground pipeline features such as valves can be protected by concrete piers

TAPS Photo by Charles Kay

DISBONDED PIPE TAPE COATING

or boxes and appropriately marked to avoid accidental damage.

Most potentially active landslide areas could be avoided during centerline selection. If minor local landslide areas must be crossed, the pipe wall thickness could be increased and—as previously discussed—slope-stabilizing measures could be used.

Notification of the appropriate officials about construction activities, leaks, or accidents that may affect the pipeline could be simplified by having one central state toll-free number. The operator would receive all calls about activities affecting the pipeline. Along with this system there could be a detailed plan of action by the agencies having jurisdiction to ensure rapid response to accidents (or situations with potential for accidents).

External Corrosion and Abrasion

The pipe would be coated before being shipped to the construction site. The coating material selected must (1) prevent corrosion, (2) have sufficient adhesion to the metal surface to effectively prevent moisture from getting between the metal surface and the coating, (3) be durable enough to resist cracking, (4) have sufficient strength to resist damage from handling and soil stress, and (5) have properties supplemental to and compatible with cathodic protection to meet code specifications. The state could investigate the past effectiveness of the particular coating selected by NTPC to ensure the best possible protection.

After bending and welding, the welded pipe joints would be field-coated and the entire pipe coating electronically inspected for defects. The electronic inspection equipment is capable of detecting pinhole-sized imperfections. Any defects found would be repaired and the pipe retested before it is lowered into the trench. The pipe coating would be susceptible to damage when the trench is backfilled unless proper care is exercised. If damage occurs but is not repaired, corrosion leaks in the pipe can later occur. Bedding material is normally used to protect the pipe during backfilling where coarse backfill or rock conditions are encountered.

NTPC proposes to install an impressed-current cathodic protection system immediately after the pipeline begins operation (NTPC 1978a). This accepted industry practice of installing the protection system after operation begins results in a more efficient system than if it had been predesigned and installed during construction, because actual soil resistivities and pipe-to-soil electrical potentials can be measured and used in the design.

Keeping the right-of-way cleared of trees and tall shrubs would reduce the chances of future pipe-coating damage from roots and bacterial corrosion.

Pipe coating and cathodic protection drastically reduces the incidence of corrosion leaks in pipelines (NTSB 1978). Selecting the most effective coating and applying it to the entire pipe in both shop and field could provide the necessary protection from corrosion. Ensuring the completeness of pipe coating and the prevention of damage as the pipe is laid and covered could be included as part of NTPC's quality-control program.

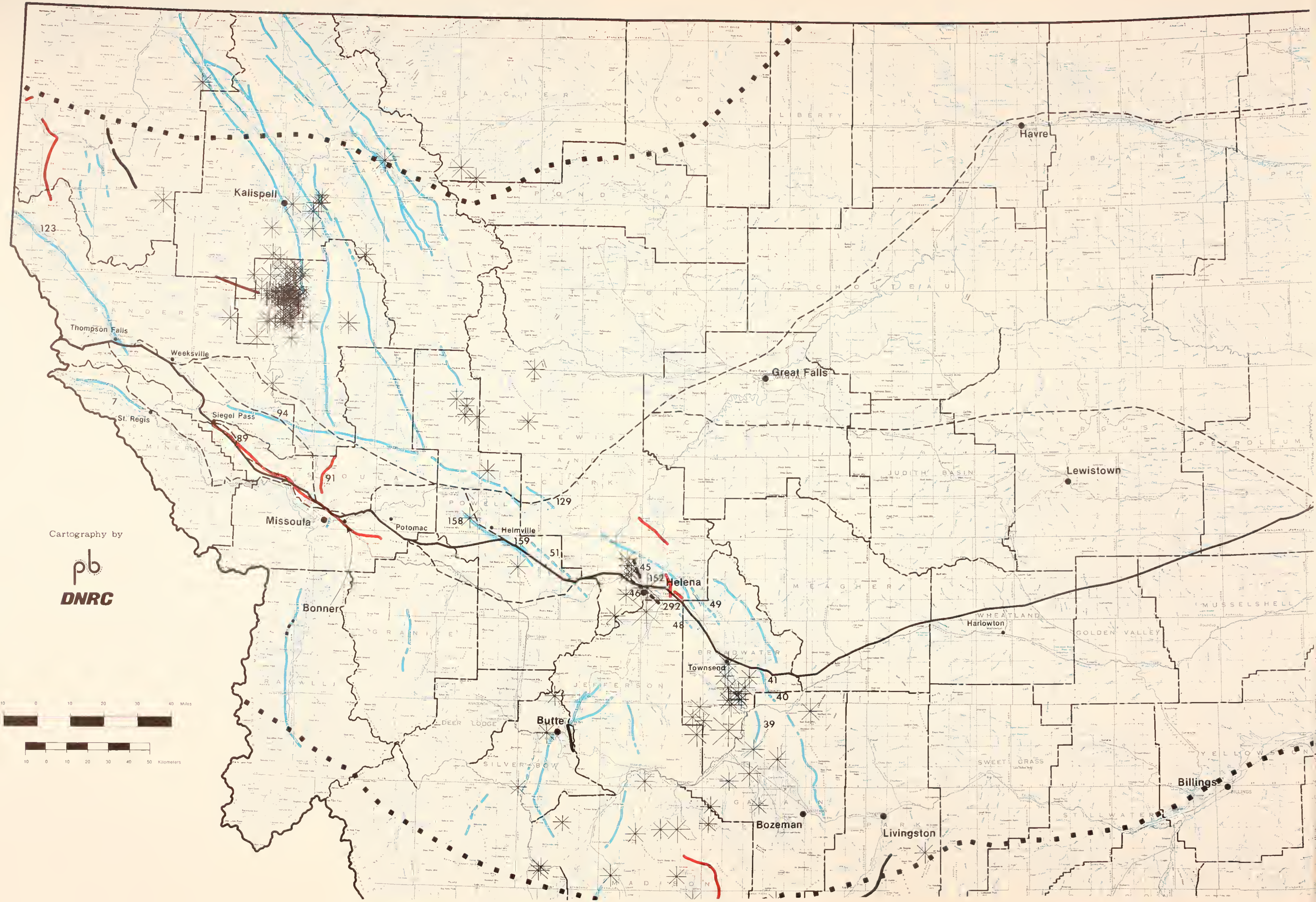
Inspection and Quality Control

NTPC's present outline of its proposed organization, procedures, and personnel estimates appears to be adequate for the project. The final draft of the quality control and inspection plan could address the specifics of management chain-of-command, inspection procedures, inspection priorities, and delegation of authority to enforce the project specifications. NTPC's final plan could be drafted in cooperation with state agencies to provide adequate protection for Montana's resources. The generality of the system design to date reinforces the desirability for continued state involvement in the final preparation of NTPC's quality control and inspection plan.

TAPS Photo by Charles Kay

HYDROSTATIC TEST DISCHARGE WATER WASHING DITCH SPOILS INTO A STREAM

MAP NO. THREE



Kalispell
Thompson Falls
Weeksville
St. Regis
Siegel Pass
Missoula
Potomac
Helmville
Bonner
Havre
Great Falls
Lewistown
Helena
Townsend
Harlowton
Butte
Bozeman
Livingston
Billings
G L A C I E R
T O O L E
L I B E R T Y
H I L L
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F E R G U S
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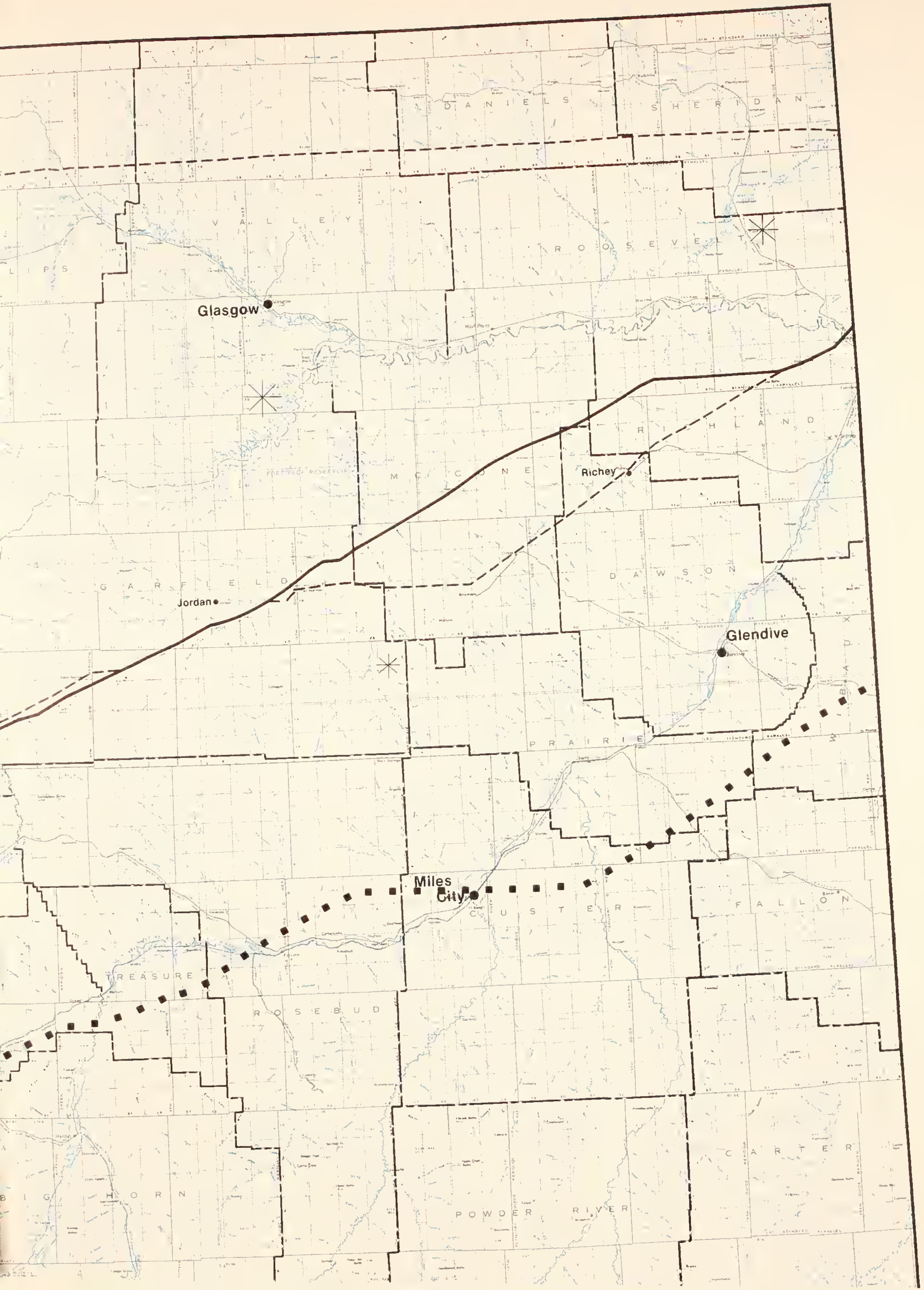


MAP NO. THREE

EARTHQUAKE HAZARDS

FAULT AGES

- Historic and Recent (within last 10,000 years)
- Pleistocene (10,000 to 2 million years ago)
- Late Cenozoic (within last 26 million years)
- Uncertain Age

Faults Discussed in Draft EIS

NO.	NAME
7	Osburn
39	Clarkston Valley
40	Unnamed-Located Southeast of Townsend
41	Unnamed-Located Southeast of Townsend
45	Scratchgravel Hills
46	Prickly Pear
48	Unnamed-Located Southeast of Helena
49	Unnamed-Located Southeast of Helena
51	Avon Valley
89	Ninemile
91	Jocko
94	St. Mary's
123	Hope
129	Northeast Edge of Lincoln Valley
152	Unnamed-Located Southeast of Helena
158	Helmville
159	Helmville Northwest Extension
292	Unnamed-Located Southeast of Helena

Historical Earthquakes

(Size of symbol is proportional to magnitude. All Montana earthquakes of magnitude greater than one recorded through 1977 are represented.)

■ ■ ■ ■ ■ ■ 100 Km distance, measured from the northernmost and southernmost routes.

EARTHQUAKE HAZARDS

Material Manufacturing

NTPC has not described in detail the proposed inspection and quality-control procedures to be used during manufacture of materials. The usual industry practice is to have independent inspection firms certify that the pipe, other materials, and equipment are manufactured and assembled according to the applicable specifications and codes.

Testing

Hydrostatic testing of the pipeline would be done by the contractors. NTPC has stated that all pipe would be hydrostatically tested to at least 125 percent of maximum design pressure of the section being tested, and that a detailed testing program would be proposed by the contractor and approved by NTPC. The testing would also include valves, piping, and other facilities at the pump and delivery stations. This is all in compliance with applicable codes and industry practices.

NTPC proposes to radiographically examine 100 percent of the pipeline welds. This exceeds the ANSI code requirements.

ASSOCIATED FACILITIES

NTPC has stated that all pump stations and delivery facilities would be designed in accordance with the appropriate standards (NTPC 1978a). These standards cover design, construction, testing, operations, and maintenance.

NTPC's design includes containment berms around all tanks, but not surrounding the exposed pipe. In the event of a spill, it would be necessary to use spill containment procedures. Additional safety could be achieved by constructing a containment berm around all oil-carrying structures. Potential spill impacts could also be reduced if associated facilities were designed to use natural terrain features to minimize spreading. Critical or sensitive areas could be avoided when locating the facilities. These considerations are not addressed in NTPC's "Oil Spill Contingency Response Plan," other than a provision for regular inspection.

NTPC states that structures such as pump stations and delivery stations would be protected by security fences and area lighting, and that there would be frequent ground and air partols. NTPC could also install sensors to indicate if the fences or buildings have been opened.

NTPC has not given site-specific information for sources of aggregate, bedding, padding, and other materials for earthen structures. Existing suppliers of these materials may have shortages.

The proposed pipeline would need electrical power at several points along its length, primarily at the pump stations and at the check and safety valves. The pump stations would be handling heavy, continuous loads and would require delivery of power at transmission voltage of 69-kV or higher. The valves would require only light distribution voltage, as their loads would be intermittent and small.

The major concerns associated with electrical supply for the Northern Tier Pipeline are construction of transmission lines, substations, and generation units (if required). NTPC does not propose to construct any of these facilities. Instead, they would be provided by the appropriate utility companies. The design and construction of these facilities is regulated by the Board and Department of Natural Resources and Conservation. No construction of transmission lines falling under the jurisdiction of the Montana Major Facility Siting Act has been proposed (see "Electrical Service," p. 54, and "Social and Economic Concerns," p. 57).

Projections from available information on power demand indicate a need for 132 to 139 MW of generation to meet the electrical demands of the proposed action in Montana. This power would be provided by the utility companies.

OPERATION AND MAINTENANCE

General Procedures and Personnel

NTPC's proposed operation and maintenance plans are in accordance with accepted industry practices for a remotely controlled pipeline system. The proposed personnel requirements appear adequate.

Permanent Right-of-way

Operation and maintenance activities require a permanent right-of-way for periodic maintenance, inspections, and line repairs. A permanent right-of-way and easement has five major functions: (1) it protects the pipeline from damage by prohibiting heavy traffic directly over the pipe bed and by preventing large tree roots from damaging pipe coating; (2) it prevent encroachment of structures which may hinder access or maintenance; (3) it allows visibility of the area above the pipeline from the air so that oil leaks or pipeline damage can be quickly detected; (4) it allows speedy movement of machinery to all points along the pipe for maintenance, on-the-ground inspection, and emergency measures; and (5) it allows possible reexcavation or reclearing of the pipeline vicinity in case of emergency pipe repair or oil-spill control.

NTPC has proposed a 23-m-wide (75-ft-wide) permanent easement and cleared right-of-way on state and private land and a 16-m-wide (54-ft-wide) permanent easement and cleared right-of-way on federal land. (The latter width is the maximum allowed by federal law on federal land; this can be changed by federal administrative order if sufficient reason exists for a wider right-of-way.) However, the amount of land actually required for a permanent right-of-way could be less than these widths, depending on local vegetative cover, land use, and slope, which would influence accessibility.

On agricultural land, crops would be grown over the entire area, and the right-of-way would be virtually indistinguishable from adjacent lands. The crops could be driven over by maintenance vehicles if necessary. The reclaimed right-of-way in rangeland (grassland or shrub-steppe) would be similar to adjacent land, and native plant communities could be allowed to reestablish over the pipe as long as they did not restrict the access of necessary machinery or vehicles.

Generally, a strip 3 m (10 ft) wide directly above a pipeline must be kept cleared of trees and shrubs. In forested areas, an additional 6 m (20 ft) would be maintained free of timber to serve as an access road. Timber and shrubs could be allowed to reestablish on the remainder of the right-of-way, although some regrowth might have to be cleared again if an emergency required use of heavy equipment (for example, to reexcavate pipe). This clearing may cause delays in emergency maintenance.

While a permanently cleared right-of-way as narrow as 9 m (30 ft) may be adequate, a permanent easement of 15 to 23 m (50 to 75 ft) would be desirable from NTPC's standpoint, especially on private lands. This allows clearing and excavation to be legally done in an emergency, and prevents dwellings and other structures which restrict maintenance from being constructed close to the pipe. It is important to note that all of the easement need not be cleared to accomplish this.

Supervisory Control System

The control system would be only as effective as the personnel operating and maintaining it. Strict procedures for all maintenance, repair, and inspection operations would be important, as would a detailed course of action for predictable problems associated with the control equipment. NTPC's quality-control plan will cover operation and maintenance; the state could review this to ensure that these plans are complete.

The control system includes a leak detection system which would be designed to detect a leak as small as 0.5 percent of the throughput volume. The location of the leak could be determined only as being between the control stations sounding the alarm. The automatic valves along the line must be reliable because they would be of major importance in isolating the leak and shutting down the line.

Oil Spill Risk Evaluation

Oil spills do occur in spite of all precautions. The possible causes are numerous, and range from small leaks caused by corrosion to complete ruptures from equipment accidents, landslides, or earthquakes. (See table 26 for recent pipeline breaks in Montana.) This analysis defines a major spill as one which incurs as spill volume in excess of 800 m³ (5,000 barrels) and a minor spill as one which incurs a spill volume of less than 800 m³ (5,000 barrels). In an attempt to predict the frequency of different types of spills, a review of the available data on other pipelines was made.

USDOT has required reporting of liquid pipeline accidents for over ten years; these data are published in annual summaries. In the latest available summary, USDOT tabulated the accidents for all liquid pipelines. (These data do not include accidents to intrastate pipelines or accidents with losses of less than 8 m³ (50 barrels) of liquid petroleum.)

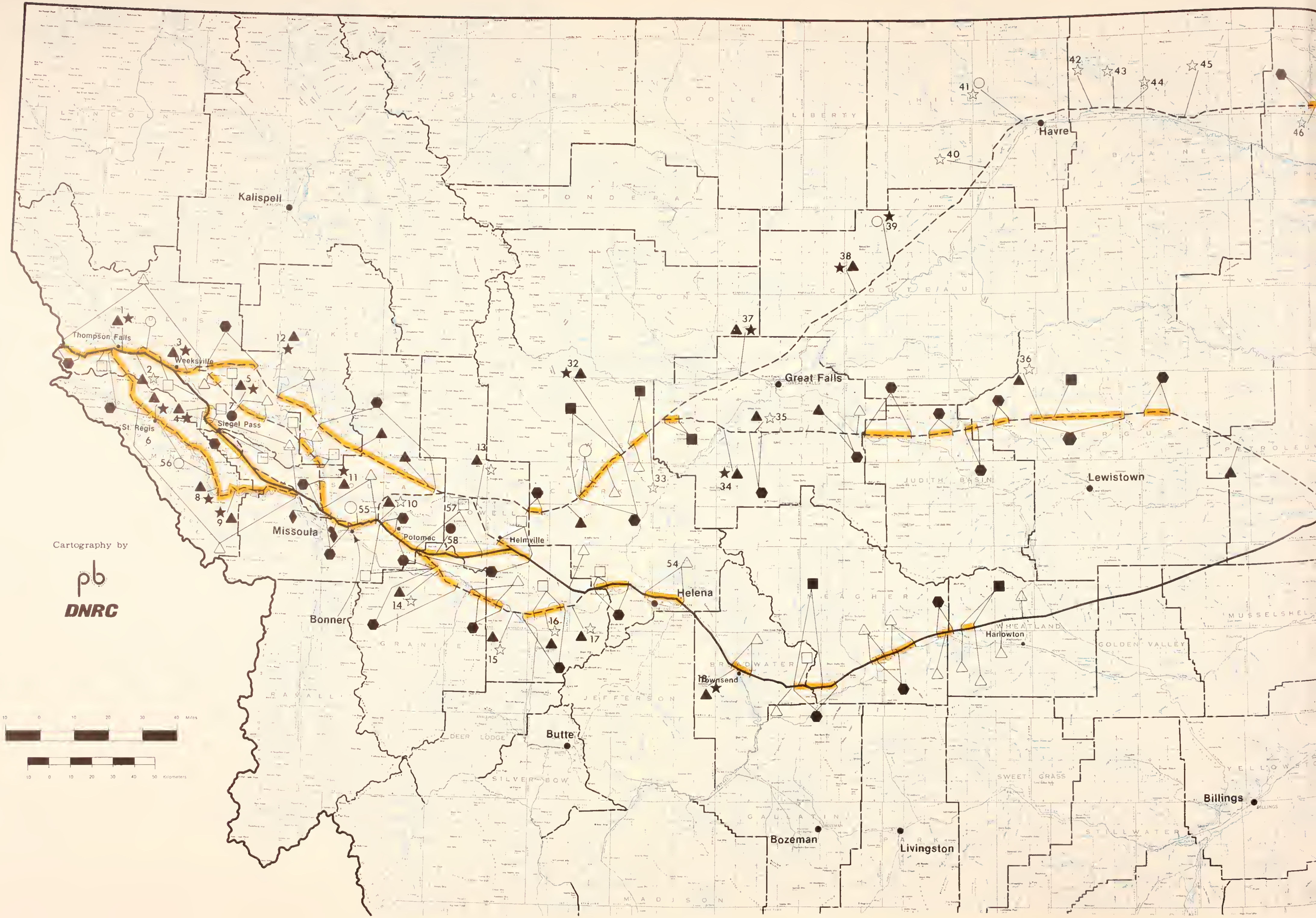
The USDOT summary lists the accidents in three ways: by cause (such as external corrosion), by age of pipeline according to installation date, and by commodity being transported. The summary does not give the pipe size, location of accident, or land use at the accident site. Of 238 total spills reported in 1977, the largest number (seventy-five) were the result of equipment rupturing the line and the second largest number (forty-five) were from external corrosion. Accidents at associated pipeline facilities accounted for nineteen spills, and incorrect operation by pipeline personnel accounted for four. This indicates that equipment ruptures and corrosion accidents are the most probable causes of oil spills. Facility accidents and operating mistakes are the next most likely kinds of accidents. The average oil spill size from crude oil lines was 100 m³ (680 barrels), with the maximum recorded spill in 1977 being 1,670 m³ (10,500 barrels).

TABLE 26. PIPELINE BREAKS IN MONTANA IN 1978

DATE	PIPELINE COMPANY	COUNTY	STREAM(s) AFFECTED	AMOUNT AND TYPE OF OIL SPILL (in barrels)	CAUSE	REMARKS
1/13/78	Texas Pipeline Co	Toole	None	15, crude	Split in gathering line	
2/22/78	Texas Pipeline Co.	Toole	None	160, crude	Corrosion of 8-inch trunk line	50 barrels not recovered
2/22/78	Cenex	Petroleum	Musselshell River	10, crude	Cut in 4-inch line, caused by bulldozer	Oil spilled onto frozen Musselshell
2/27/78	Westco Pipeline Co	McCone	None	30, crude	Cut in line, caused by bulldozer	
3/17/78	Continental Pipeline Co	Cascade	Belt Creek, Missouri River	700, condensate	Break in 8-inch pipeline	Oil could be seen on Missouri for 3 days
3/22/78	Continental Pipeline Co.	Musselshell	Musselshell River	50-75, condensate	Break in 4-inch line caused by bank cave-in	
3/27/78	Continental Pipeline Co	Petroleum	Box Elder Creek Musselshell River	20, crude	Flood washout of line	
3/28/78	Texas Pipeline Co	Toole	None	400, crude	Corrosion of 6-inch trunk line	Snow and mud slowed cleanup
3/31/78	Shell Oil Co	Fallon	None	20, crude	Break in line	Break went over 3 months unnoticed
4/10/78	Yellowstone Pipeline Co.	Powell	Unnamed spring-fed stream	2, refined product	Cut in line, caused by bulldozer	Rain washed oil into stream
4/12/78	Phillips Petroleum Co.	Glacier	Rocky Coulee Creek	2, crude	Split in line, caused by extremely cold weather	Line split at creek crossing
4/18/78	Western Oil Transportation Co & Miami Oil	Glacier	Two Medicine River	500, crude	Corrosion and extremely cold weather	40 miles of stream affected
5/3/78	Texaco, Inc.	Rosebud	None	35, crude	Break in coupling on 3-inch line	
5/17/78	Marathon Pipeline Co.	Carbon	Silvertip Creek Clarks Fork Yellowstone, and mainstream Yellowstone	3,000, crude	Break in 6-inch crude line; caused by rock slide	3,000 barrels lost but 1,500 barrels recovered
6/1/78	Phillips Petroleum Co.	Cascade (Benton Lake National Wildlife Refuge)	Lake Creek	20, crude	Break in crude line, caused by external corrosion	Rain washed the oil into Benton Lake
6/6/78	Cenex, Inc.	Yellowstone	None	525, diesel	Cut in line, caused by contractor	Diked before reaching surface water
6/8/78	Texas Pipeline Co.	Glacier	None	40, crude	Corrosion in 3-inch crude line	
6/16/78	Texas Pipeline Co	Glacier	Big Rock Coulee Cut Bank Creek	10+, crude	Corrosion in 3-inch crude line	
7/12/78	Texas Pipeline Co	Glacier (Cut Bank Tank Farm)	None	100, crude	External corrosion of gathering line	
8/9/78	Husky Oil Co.	Carbon	Clarks Fork Yellowstone	10, crude		Oil still present on banks one week later

SOURCE Knudson 1979
CONVERSIONS 1 barrel = 42 U.S. gallons; 1 U.S. gallon = .003785 m³; 1 in = 2.54 cm
NOTE Many breaks were in small-diameter lines

MAP NO. FOUR



Kalispell
Thompson Falls
Weeksville
Siegel Pass
St. Regis
Missoula
Bonner
Potomac
Helmville
Helena
Great Falls
Havre
Lewistown
Harlowton
Townsend
Butte
Bozeman
Livingston
Billings
L I N C O L N
G L A C I E R
T O O L E
L I B E R T Y
H I L L
B L A I N E
F L A T H E A D
P O N D E R A
T E T O N
C H O U T E A U
C A S C A D E
F E R G U S
P E T R O L E U M
J U D I T H B A S I N
L E W I S A N D C L A R K
M E A G H E R
W H E A T L A N D
M U S S E L S H E L L
G O L D E N V A L L E Y
B R O A D W A T E R
J E F F E R S O N
G R A N I T E
R A V A L L I
D E E R L O D G E
S I L V E R B O W
G A L L A T I N
P A R K
S W E E T G R A S S
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Y E L L O W S T O N E
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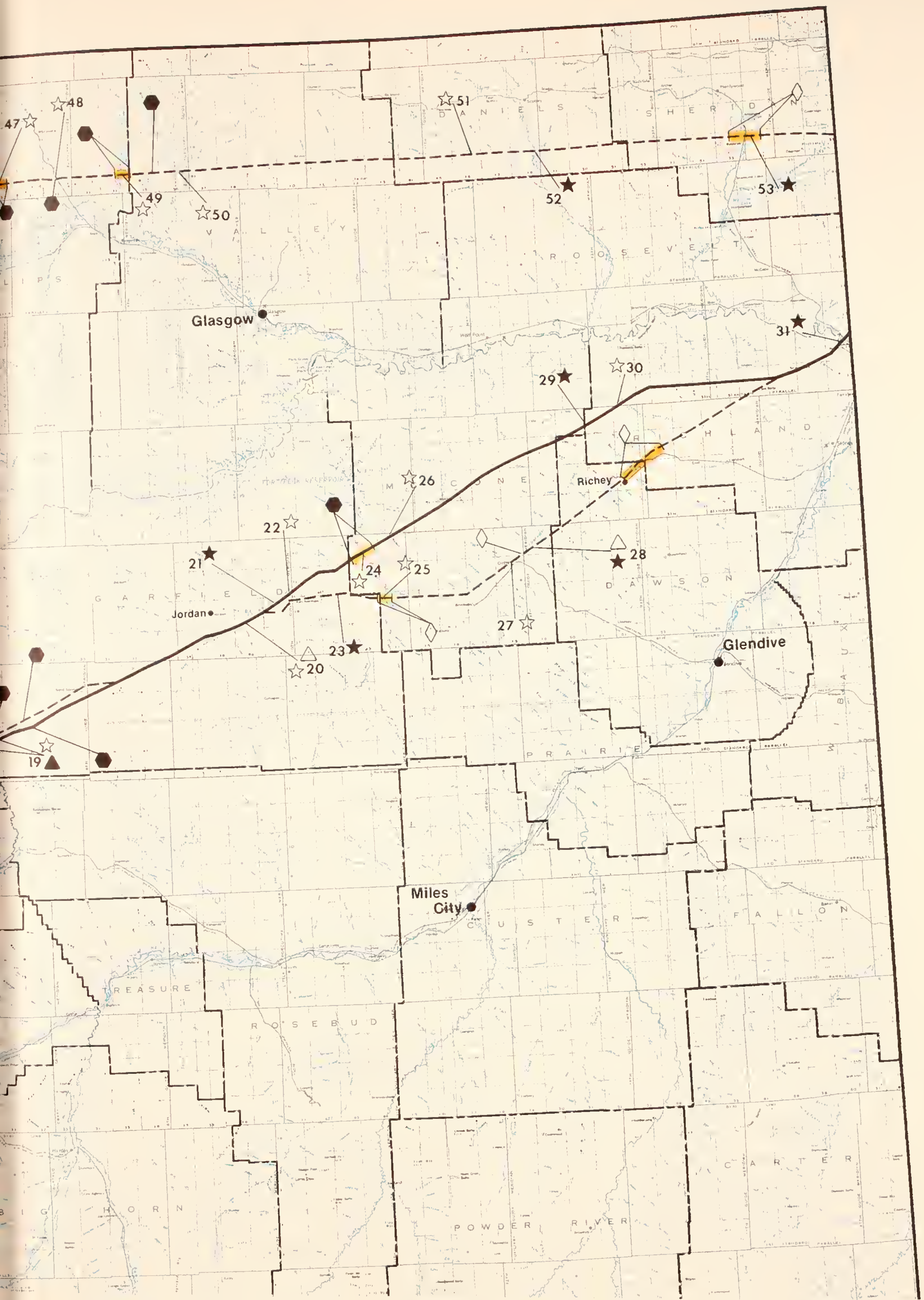

MAP NO. FOUR

ENGINEERING AND HYDROGEOLOGIC CONCERNS

All Areas are Sensitive

TERRAIN, ENGINEERING, AND HYDROLOGY

● Constricted Area

Special Construction - width of right-of-way is reduced below 75 ft by natural or man-made obstacles.

○ Excessive Slope

Special Construction - slope presents difficult problems to pipe installation

★ Major River Crossing (Class 5)

☆ Minor River Crossing (Class 3 or 4)

GEOLOGY AND MINERAL DEPOSITS

(Excludes Earthquake Hazard)

♦ Slope Failure Hazard

■ Pipe Ditch Requires Drilling and Blasting

□ Pipe Ditch Does Not Require Drilling and Blasting

◇ Lignite Deposits

GROUNDWATER

▲ Aquifer Adjacent to Major Stream

△ Shallow Aquifer - Less than 75 ft deep, good-quality water

SOIL

⬢ High Erosion Potential

NO.	DESCRIPTION	NO.	DESCRIPTION	NO.	DESCRIPTION
1.	Clark Fork Crossing	21.	Big Dry Creek Crossing	41.	Milk River Crossing
2.	Thompson River Crossing	22.	Frazier Creek Crossing	42.	Redrock Coulee Crossing
3.	Clark Fork Crossing	23.	Little Dry Creek Crossing	43.	Lodge Creek Crossing
4.	Clark Fork Crossing	24.	Timber Creek Crossing	44.	Battle Creek Crossing
5.	Flathead River Crossing	25.	Timber Creek Crossing	45.	Thirty Mile Creek Crossing
6.	St. Regis River & Clark Fork Crossing	26.	Nelson Creek Crossing	46.	Little Cottonwood Creek Crossing
7.	Quinn's Hot Springs-Siegel Pass Area	27.	Horse Creek Crossing	47.	Cottonwood Creek Crossing
8.	Clark Fork Crossing	28.	Redwater Creek Crossing	48.	Whitewater Creek Crossing
9.	Clark Fork Crossing	29.	Redwater Creek Crossing	49.	Frenchman Creek Crossing
10.	Blackfoot River Crossing	30.	East Redwater Creek Crossing	50.	Rock Creek Crossing
11.	Jocko River Crossing	31.	Missouri River Crossing	51.	West Fork Poplar River Crossing
12.	Flathead River Crossing	32.	Dearborn Creek Crossing	52.	Poplar River Crossing
13.	Blackfoot River Crossing	33.	Flat Creek Crossing	53.	Big Muddy Creek Crossing
14.	Clark Fork Crossing	34.	Missouri River Crossing	54.	Helena Valley Aquifer Area
15.	Clark Fork Crossing	35.	Smith River Crossing	55.	Blackfoot River constricted by steep canyon walls
16.	Little Blackfoot River Crossing	36.	Judith River Crossing	56.	Many constricted areas in this segment
17.	Little Blackfoot River Crossing	37.	Sun River Crossing	57.	Locally steep slopes in this segment
18.	Missouri River Crossing	38.	Teton River Crossing	58.	Bear Gulch constricted by steep canyon walls.
19.	Musselshell River Crossing	39.	Marias River Crossing		
20.	Sand Creek Crossing	40.	Sage Creek Crossing		

ENGINEERING AND HYDROGEOLOGIC CONCERNS

A leak rate per mile for leaks caused by external corrosion in coated, cathodically protected pipes cannot be predicted using the USDOT data, since the mileage of coated pipe is not known. According to the National Transportation and Safety Board, pipe coating and cathodic protection is reducing the incidence of pipeline corrosion leaks. In 1968, when the majority of pipelines were uncoated or had no cathodic protection, there were 229 corrosion leaks reported. In 1977 only 45 corrosion leaks were reported; coating and cathodic protection had been installed on most new lines and many old lines had been upgraded with these corrosion protection features. The total mileage of pipe in service has increased in this time span also, so there has been a significant reduction in leaks per mile.

On a national average, new pipelines have a spill frequency from all causes of 0.0022 spills per mile per year (USDI 1979). Thus, should the proposed pipeline equal this national average, 1.4 spills per year would occur on the Northern Tier Pipeline in Montana. Ninety-six percent of all crude oil pipeline spills reported to USDOT have been classified as minor. Thus, assuming the Northern Tier pipeline would be similar to other pipelines, a major spill may be expected to occur once in every twenty-two years. Such a spill could be as large as 10,200 m^3 (64,000 barrels), if all of the oil were emptied from within the maximum distance between block or check valves.

It is not valid to project the number or magnitude of spills to be expected for the proposed pipeline, however, without taking into consideration the advancement of pipeline technology and the limited data on large-diameter pipelines. For example, NTPC's 107-cm-diameter (42-in-diameter) line would be less susceptible to pipe breaks from small excavation equipment than would a smaller line, because of pipe size and wall thickness. The recent improvement in the technology of corrosion protection could also be expected to reduce these leaks below the national averages.

Experience has shown that the incidence of oil spills during start-up operations on large-diameter, modern, crude-oil pipelines may exceed the yearly operating average presented above. For example, five oil spills occurred in the first several months of operation of TAPS, and several others have occurred since then. During startup, human error coupled with a design failure resulted in an explosion as the crude oil reached TAPS pump station number 8. The blast completely destroyed the pump building. At pump station number 9, a different design failure coupled with human error resulted in the shutdown of the station when crude oil flooded the building and flowed out the door. A front-end loader backfilling around check valve number 7 on the Alaskan North Slope broke a 5-cm (2-in) bypass pipe, allowing approximately 2,400 m^3 (15,000 barrels) of crude oil to escape onto the tundra. One month later, in a separate incident, crude oil was discovered in Washington Creek north of Fairbanks. Upon investigation, it was discovered that the bolts on check valve number 64 had not been properly tightened and oil had leaked for thirty days before it was discovered. And, in another incident on TAPS a 1,900 m^3 (12,000 barrel) spill was caused by vandalism. A hole about 2 cm (0.8 in) in diameter was made through which oil was lost at an estimated rate of 75 to 300 L (20 to 80 gal) per second. On this spill, over five hours were required to shut down the pipeline because of a valve-closing failure.

Although it is impossible to quantitatively predict spills from accidents or human error, it may be feasible to compare the relative risks of rupture from different kinds of accidents. This is done in table 27. The rankings of spill risk categories are necessarily subjective to some extent; they are, however, based upon data on past spills and represent the best judgment of DNRC. The potential risks from different activities are defined as low, moderate, or high, and the rate of spill is described as slow or rapid. The spill rate, rather than spill size, is used to classify each type of accident because the rate is more predictable. The amount of oil lost would depend upon the time lapse from the beginning of the leak to its detection and plugging. For this reason, a slow leak may remain undetected for a longer period of time. Detection of leaks under riverbeds, under snow or ice, or in remote areas, would be particularly difficult. Such leaks could eventually result in spills exceeding those of a much faster leak.

The amount of oil lost from a pipeline accident is primarily dependent on six variables: (1) the magnitude of the damage to the pipe; (2) the location of the damage; (3) the sensitivity of the leak detection system; (4) the length of time to detect a pipeline leak, shut the system down, and isolate the line segment; (5) the operating pressure of the pipeline; and (6) the capacity of the pipeline. The total oil loss from a major accident would be proportional to the amount of oil in the pipe and the pressure.

The adequacy of the NTPC's "Oil Spill Contingency Response Plan" would affect the response time of the spill containment personnel and the effectiveness of their operations.

TABLE 27. RELATIVE RISK, RATE, AND SIZE OF OIL SPILLS DUE TO DIFFERENT KINDS OF ACTIVITIES

ACTIVITY	RISK POTENTIAL[1]	SPILL RATE[2]	SPILL SIZE[3]
Accidental rupture by other persons (i.e., equipment striking the line) in urban areas	High	Rapid	Generally, a minor spill would result, although rupture by a large piece of equipment could create a major spill
Accidental rupture by other persons in rural areas	Moderate	Rapid	Generally, a minor spill would result although rupture by a large piece of equipment could create a major spill
Accidental spill through improper operation of the system	High	Rapid	Minor or major spill would result
Vandalism	Moderate	Slow	Generally minor spill would result
Earthquakes and landslides	Low	Rapid	Major—These accidents would probably result in a complete rupture
Corrosion	High; modern corrosion prevention techniques are apparently effective, but new and thus unproven	Slow	These could be major in areas where detection is difficult
Failure of weld	Moderate	Slow	These could be major in areas where detection is difficult

[1] Risk potential is defined by the following terms
- Low — Only a remote possibility exists of a spill from this activity during the projected life of the pipeline
- Moderate — At least one spill may result from this activity during the life of the pipeline
- High — Several spills may occur as a result of this activity

[2] Spill rates are defined by the following terms
- Slow — Spill rate would be so small that the control system would not detect the leak
- Rapid — Spill rate would be great enough that the control system would detect the leak

[3] Spill sizes are defined by the following terms
- Major — Total oil lost would be in excess of 800 m^3 (5000 barrels)
- Minor — Total oil lost would be less than 800 m^3 (5000 barrels).

ABANDONMENT

If the pipeline were taken out of service, the crude oil would be flushed from the system with water, and the water would be removed, treated, and discharged. The pipeline could then be abandoned in place or the pipe removed and salvaged. If removed, the pipe would be cut into manageable lengths and hauled away, and the area reclaimed. In some cases it may be necessary to bring in backfill to restore the right-of-way to its original condition.

MITIGATING MEASURES

The following measures, if followed, would help to ensure a safe, reliable pipeline with minimal problems. The public is invited to critically evalute these measures. After comments are received from the public, NTPC, and the permitting agencies, the measures will be revised as appropriate. The final EIS will include mitigation recommended for state permit conditions. Only those measures included in the permit conditions would be legally enforceable. Other mitigation would have to be stipulated in written agreements between NTPC and another party, such as a landowner.

Pipeline Design and Construction

During design and construction of the proposed pipeline, potential adverse impacts would be mitigated by:

1) Observing industry codes.
2) Having the state review the final designs of aerial and drilled river crossings.
3) Crossing major rivers, such as the Missouri and the Clark Fork, by directional drilling where feasible. No conclusion about the drilling feasibility of any crossing could be drawn until after the consideration of detailed information about subsurface geology.
4) Using buried crossings for large rivers. This method of crossing has a slight advantage over aerial crossings because the buried pipe would be less likely to break.
5) Investigating and incorporating protective measures to reduce the hazards of malicious and accidental damage to aerial crossings.
6) Crosschecking NTPC's streambed data with DNRC's before calculating and adopting final design depth-of-burial predictions at major crossings.
7) Completing detailed geological and geophysical studies of critical faults before final route selection, including the faults in the Townsend, Helena-Lincoln, and Nevada Valley areas, the Ninemile Fault, and possibly the Hope Fault.
8) Allowing in the system design for earthquakes of magnitude 7 in the Townsend, Nevada Valley, and Helena-Lincoln areas.
9) Requiring increased pipe wall thickness and special engineering techniques, such as toe buttressing and under-drainage, to stabilize the ground at any crossing of areas with potential for landslides and slumps. The risk of landslides and slumps caused by earthquakes would have to be examined by site once a final routing was established.
10) Incorporating thorough seismic considerations in the design of aboveground facilities located in seismic-risk areas. These facilities would be significantly at risk during earthquakes of high intensity.
11) Taking extreme care during construction to prevent damage to other lines, such as powerlines or other pipelines.
12) Using stringent quality-control measures to ensure that the pipe is completely coated and protected from damage during installation and backfill.
13) Having the state review the locations and spacing of check valves and manual and automatic block valves.
14) Ultrasonically testing the steel plate used for the pipe before pipe manufacture.
15) Burying warning tape above the pipe to alert excavators. Regulations require markers only at railroad, river, and highway crossings, but more signs could be posted.
16) Using strict quality control and inspection to ensure that pipe with the proper wall thickness is used at all locations.

Pipeline Operation

During operation and maintenance of the pipeline, potential adverse impacts would be minimized by:

1) Requiring twice-weekly ground patrols of pump stations and delivery stations.
2) Establishing a "one-call" system for reporting any activity in the vicinity of the pipe so all appropriate agencies are notified.
3) Having the state review final spill containment and prevention plans for the associated facilities.

CHAPTER SIX

IMPACTS AND MITIGATING MEASURES

Chapter six includes discussion of the potential adverse and beneficial impacts of the Northern Tier Pipeline and suggestions for possible mitigation. Specific impacts which may occur on each route are discussed in appendix G, and an evaluation and comparison of routes based on these impacts is included in chapter seven.

Mitigation for a particular concern may conflict with mitigation pertaining to different concerns. For instance, mitigation for minimizing impact on visual quality may conflict with measures suggested for reducing impacts on aquatic life and habitats. Paralleling a waterway would avoid impacts associated with crossing but, in turn, could increase the risk of oil getting into the water if a leak occurred. Keeping the right-of-way as narrow as possible would damage less land, but may slow construction and hinder moving equipment to an oil spill.

Other decisions involving tradeoffs would have to be made. For instance, is it better to choose a route which has more small stream crossings but fewer major river crossings than other routes? Is it better to save an eagle's nest but impact critical elk winter range? Do the economic benefits which may accrue to communities if construction camps are not used outweigh the probable strain on housing and services?

The final EIS will include recommendations to the permitting agencies for mitigation to be included in permit conditions. Before making these recommendations, it is important that DNRC receive comment on the measures and the potential tradeoffs. Only mitigation included in the permit conditions would be legally enforceable. Other mitigation would have to be stipulated in written agreements between NTPC and another party, such as a landowner.

NTPC has already committed to many mitigating measures, of which all are not addressed in this chapter. The oil spill contingency plan and the reclamation plan submitted by NTPC are mitigation, and many mitigating measures have been included in the pipeline system design. A list of mitigation agreed to by NTPC will be included in the final EIS.

Also included in chapter six is a discussion of MEPA considerations as they relate to the environmental and social concerns. MEPA considerations as they relate to the overall impacts of the project are discussed in chapter eight. MEPA considerations include irreversible and irretrievable commitments of resources; insignificant and significant impacts; short- and long-term impacts; and nonmitigable adverse impacts.

Unless otherwise documented, findings and conclusions made in this chapter are supported in the Northern Tier Reports (see chapter one). As previously mentioned, the EIS addresses the impacts of road construction considering even the right-of-way as a road. New access roads may be necessary for any of the alternative routes, although NTPC currently does not propose any new construction for access. The company also does not plan on using construction camps. However, because these camps may be appropriate mitigation for impacts on rural areas, they are discussed in "Social and Economic Concerns," p. 57.

GEOLOGICAL CONCERNS AND MINERAL RESOURCES

DNRC evaluated the potential and known mineral resources along the routes and located other geologic phenomena of scientific or public interest. Geologic hazards such as floods, landslides, slumps, active faults, and earthquake were identified and are discussed in chapter five. Areas where the proposed pipeline may encounter geologic hazards are shown on map 4, p. 48.

Impacts

Access to Mineral Resources

A potential impact of the proposed pipeline would be blockage of access to resources, particularly valuable mineral deposits that are subject to open-pit mining. Construction of the pipeline across a strippable mineral resource such as placer gold, lignite, or bentonite would preclude mining of that mineral beneath the right-of-way. The costs of mineral extraction in nearby areas may increase because the mining plan would have to be designed so that the right-of-way remains undisturbed. This would entail design of stable pit backslopes along the right-of-way and probably longer, and consequently more expensive, hauls of the mineral to loading or storage sites. Operation of heavy machinery directly over the pipe would not be allowed.

Depending on the areal configurations of ownership, the pipeline might isolate portions of a mining property; for instance, it may cut across the corner of a lignite lease.

It is improbable, however, that the increased costs or nonavailability of the mineral resource would reduce the size of the reserves to noneconomic proportions and prevent resource development. Nonetheless, it would be desirable to route around rather than over these deposits.

Strippable lignite in eastern Montana is the only mineral resource identified in this study of sufficient value to possibly justify route changes. Much of the strippable lignite in eastern Montana will probably be mined during the next century. Were the pipeline to be routed through lignite areas, one or several mines could be near the pipeline during its operation. For marginal deposits, mining could be postponed until the pipe is abandoned; the fuel would still be available for mining at that time.

Industrial geologic resources such as lime, silica, barite, phosphate, fire clay, and bentonite are common and easily available; these could be avoided by centerline adjustment. Surface exposures of metallic mineral deposits in Montana are well known and are avoided by the routes. Other than local deposits of placer gold in western Montana, there are no known low-grade metallic mineral deposits subject to large-scale open-pit mining along the routes. Thus, construction of the proposed pipeline would have a negligible effect on the access or availability of industrial, metallic, and energy minerals other than lignite. Underground mining activities would not be affected by the project.

Geothermal, Oil, Natural Gas, Oil Shafe, and Uranium Resources

Construction and operation of the proposed pipeline would not significantly interfere with or physically restrict continued oil, natural gas, or geothermal resource development. Oil shale deposits in Montana are limited in extent and quality and are not technologically or economically recoverable. Oil shale production, not anticipated in Montana in the foreseeable future, would probably involve underground retorting and extraction through wells and shafts that require little land area. Shallow deposits or uranium minerals subject to open-pit recovery are not known or anticipated along any of the routes.

Unique or Scientifically Valuable Geologic Features

There were no geologic features of scientific, educational, or public interest identified within or in proximity to the routes.

MEPA Concerns

Considering the permanence of geologic resources, the impacts resulting from the withdrawal of limited areas from resource production would be local and short term. The geologic materials used for construction of the pipeline system would generally be irretrievable; however, the effects on the available resources in Montana would be negligible and would not produce an irreversible depletion on a local or regional scale.

Mitigating Measures

Location of the Pipeline and Associated Facilities

The potential for adverse impacts on the geologic environment would be reduced by:

1) Avoiding known resource areas. Many valuable geologic resources in Montana are known, easily identified, and limited in extent. Avoiding unique geologic features and known mineral resources would eliminate impacts.
2) Conducting centerline and other preconstruction studies to cross-check and supplement the available evaluations of mineral resources. Information on mineral resources is extensive, but much of it is held in confidence by private companies; the routes may cross mineral deposits that have not yet been identified or publicly disclosed.

ELECTRICAL SERVICE

The Northern Tier Pipeline would need electrical power to operate at several points along its length, primarily at pump stations and block valves. The pump stations would require delivery of power at a transmission voltage of 69-kV or higher to handle heavy continuous loads. The block valves would require only light distribution voltage because their loads would be intermittent and negligible.

Impacts

Powerline Construction

Environmental concerns associated with powerlines include the visual impacts of the structures and the opening of new rights-of-way. Impacts from either source would not be great for this project. The structures required to provide power to the valves would be small and would have negligible visual impact. Service could be provided to the pump stations by nearby existing transmission lines at whatever voltage is available. If an existing line were within 16 km (10 mi) of a pump station, the new line would be served at voltages from 100 to 230 kV, and no certification would be required under Montana's Major Facility Siting Act.

Unless a substation were built to reduce the voltage to 69-kV, the required new line would come under the Siting Act if the nearest line were greater than 69-kV and at least 16 km (10 mi) from the pump station. For example, to serve the Jordan pump station on the NTPC proposed route, a 230/69-kV substation would be built; 67 km (42 mi) of 69-kV transmission line would be constructed along the pipeline right-of-way to the pump station. A new right-of-way would not be opened (other than that required for the pipeline) and so construction impacts would be low. Single-pole, wooden structures are usually used for 69-kV lines; therefore, visual impacts would probably not be significant.

Electrical Generation

Depending on the route chosen, the pump stations in Montana would operate on 123,000 to 139,000 horsepower at full throughput peak loads, thereby using 91.8 to 97 MW of electricity. While on line, the delivery facilities would pump into storage tanks 25 percent of the time; loads during the other 75 percent of the time would range from 89.5 to 93.8 MW. Since the pump stations would run approximately 95 percent of the time (NTPC 1979c), average power requirements for full capacity throughput would range from 85.6 MW to 90.3 MW.

Most baseload generation (as opposed to generation designed for peak period use only) in this region is supplied by large thermal generation facilities, which have an average availability of 65 percent. Therefore, the Northern Tier Pipeline, on line 95 percent of the time, would require 132 to 139 MW of generation to cover down time. (See appendix D, Correspondence from MPC Regarding Electrical Power Supply.")

Operating at full capacity, the Northern Tier Pipeline would need approximately 426,380 tonne (470,000 tons) of coal each year at full throughput, assuming 8,500 British thermal units per pound. Since an acre of a typical strippable coal resource in eastern Montana is underlain by roughly 62,384 tonne (68,700 tons) of coal, it would be necessary to strip mine 2.7 ha (6.9 acres) each year for full throughput needs. Considering the smaller initial throughput, total land mined over the 20-year life of the project could amount to 50 ha (125 acres). Approximately 2,422,842 m^3 (1,965[3] acre-feet) of water would be required each year for cooling. Air quality could also be adversely affected, depending on the location and design of any new generation facilities which may be required.

A detailed discussion of the environmental impacts associated with power plants in general can be found in DNRC's **Draft Environmental Impact Statement on Colstrip Generating Units 3 & 4, 500 kV Transmission Lines and Associated Facilities**, Volume 3-A—Power Plant (Montana DNRC 1974.)

MEPA Concerns

Materials, labor and energy used in the construction of transmission lines and generation would be irretrievably commited to the project. Materials such as copper and aluminum could be salvaged and recycled upon abandonment.

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[3] Assuming 0.82 gals/kwh consumptive water use (Perry et al. 1977)

Mitigating Measures

A discussion of mitigation for impacts resulting from powerlines can be found in DNRC's **DEIS on Anaconda-Hamilton 161 KV Transmission Line** (Montana DNRC 1976). Potential averse effects of the Northern Tier Pipeline could be reduced by:

1) Using wood poles and nonreflective finishes on conductors, minimizing the visual impacts of powerlines.
2) Using existing corridors for line placement, thereby reducing land use impact.

LAND USE

Montana's land use was categorized by (1) linear patterns, such as transportation and utility land uses, and (2) site patterns, such as agricultural, urban, and suburban land uses. Also considered were land ownership, compatibility with existing corridors, planning and legal controls, and potential land use (see tables 42 and 43 in chapter seven, pp. 96 and 98 for a more specific listing). Impacts to nonsite recreation use were not considered.

Ownership and Right-of-way

Before construction, NTPC would have to acquire rights-of-way to cross any federal, state, city, county, private, and tribal land. Rights-of-way can be acquired by easement, fee ownership, or permit. Fee ownership secures the land by transfer of ownership. An easement grants use in perpetuity or for a specified time period without transferring ownership. A permit grants use without the legal guarantees afforded by fee ownership or easement.

NTPC would purchase an easement from the landowner after negotiation of easement conditions. Among these conditions would be the amount of compensation, the width of the easement, and the duration of the agreement. The landowner would be allowed to farm or ranch the land, but would be prohibited from planting trees or building any structures on the right-of-way. NTPC would have the right to construct, maintain, and operate the pipeline; to repair or replace the line if necessary; to intersect with other lines; and to ensure that nothing which would interfere with line operation encroaches on the right-of-way. Special requirements mutually agreeable to the landowner and NTPC could be included in the easement, including stipulations regarding methods of construction. Besides paying for the privilege of establishing a permanent easement, NTPC would pay for damages to crops, grazing lands, timber, fences, structures, or other property caused by pipeline construction and maintenance.

NTPC has been granted the right of eminent domain. This is the right, upon payment of just compensation, to take property without the owner's consent where necessary for public use (MCA 70-30-101) (see **Northern Tier Report No. 5**).

Planning and Legal Controls

Zoning. The primary enforceable means of controlling the use of an area of land, other than designating it a specially managed area (discussed below), is zoning. Under Montana law there are four types of zoning: county zoning, special zoning districts, municipal zoning, and extraterritorial zoning (outside incorporated municipal boundaries). County zoning will not be further discussed; there are currently few areas in Montana with county zoning, and these would have to be individually addressed.

The applicability of local jurisdiction to oil pipelines would have to be decided by the governing body of each community and county. Many zoning ordinances allow the construction of "utilities," which are generally considered to be those necessary for residences (for instance, gas, water, and power). It is possible that some communities may decide to include the proposed pipeline in this category. Other communities wishing to have influence on the siting of the pipeline may make a case for control based on some local regulation.

Special zoning districts are even more difficult to characterize. Though based on common law, they are of widely varying form. Their potential effect on NTPC's pipeline would depend on the specifics of each district.

Comprehensive Planning. Because comprehensive plans are not legally enforceable, they are not considered land use controls. However, they are the first step toward establishing controls and are an expression of local preference. Any local government with a comprehensive plan may institute zoning or other land use regulations. All of the conservation districts have comprehensive plans, as do the resource conservation and development districts and the grazing districts.

Specially Managed Areas. Specially managed areas are units of land administered in such a way that some land uses are prohibited or regulated. Tables 28 and 29, pp. 56 and 57, list the types of specially managed areas crossed by the proposed and alternative routes in Montana. These areas are shown on map 5, p. 58.

Impacts

Linear Patterns of Land Use

Impacts to linear land use would primarily involve crossings by the pipeline of roads, highways, interstate highways, railroads, irrigation canals, and other utility lines. Depending on the construction method used, impacts may include disruption of road traffic or temporary closure of rail lines. Crossing construction methods are described in chapter five.

Site Patterns of Land Use

Land Requirements. The potential land requirements are tabulated in table 42 in chapter seven. The most significant land-use impact would be the commitment of a 23-m-wide (75-ft-wide) permanently cleared right-of-way. Also affecting land use would be the additional 8 m (25 ft) of temporary construction right-of-way, pump station sites, mainline valve sites, delivery facility sites, river and road crossing staging areas, material storage and excavation sites, and access roads.

Agricultural Land Use. The four types of agricultural land considered here are: (1) irrigated and irrigable land, (2) dry cropland and hay land, (3) rangeland and dry pasture, and (4) timberland (public and private).

A season's production may be lost as a result of pipeline construction on irrigated land; however, this would depend on the timing of construction. Construction could influence agricultural production over a much larger area than the construction right-of-way. Interruption of water delivery, loss of access to land, and the creation of excavation barriers to center-pivot and line-roll sprinkler systems would impede production. If a main irrigation canal were disrupted, pipeline construction would affect extensive areas of irrigated land. Topsoil would be disrupted, thereby increasing the possibility of noxious weed production. Oil spills into or near irrigation systems during construction would severely affect any involved land, and could damage or ruin sprinkler delivery systems and pumps (see **Northern Tier Report No. 5**).

After reclamation of the cleared right-of-way, irrigated agriculture could normally be resumed over the installed pipeline. Development of any new structures would be prohibited or restricted on the permanent right-of-way. Productivity would be lowered for several years due to soil compaction and mixing. If fields were restored to level, water systems repaired, topsoil replaced, and noxious weeds controlled, there would be no major long-term impacts except for those from possible oil spills and maintenance activities. Any major maintenance involving excavation of the line would have an impact similar to the original construction and could subsequently lower productivity. The impacts of oil spills on vegetation are discussed on p. 82. If oil were spilled into water delivery systems, crops could be lost, wildlife endangered, and stock ponds and irrigation systems could be damaged. Cleanup efforts could potentially reduce productivity through removal or contamination of soil and water.

Developing new irrigation systems over the pipeline right-of-way may be difficult or impossible, depending on the system and the necessity of leveling the land to be irrigated. Leveling could expose the pipeline or reduce the amount of earth over the pipeline to an unacceptable depth. The excavation of canals over the pipeline might not be possible or might be prevented by NTPC.

The construction impacts on dryland farming would generally be less than the effects

on irrigated land. For instance, weed infestation could be more severe. Oil spills could also provide extensive long-term damage and loss of productivity (see **Northern Tier Report No. 1**).

Generally, pipeline construction would have a minor effect on livestock forage or rangeland. Reclamation may be more difficult on rangeland than on any other agricultural land because of the soils, vegetation, and lack of moisture. Noxious weeds introduced on native rangeland are hard to control. The long-range impacts on native rangelands would be more severe than to those on irrigated land. In addition, studies have shown that two crude oil constitutents, lead and phenols, are toxic to cattle and that cattle will ingest crude oil (Gingery 1979).

Timber production in the right-of-way would be eliminated for the life of the pipeline. Soil erosion could be a major impact because of the steep slopes in most of the forested areas. Wildlife habitat and watersheds would also be affected near the right-of-way for the life of the pipeline. Maintenance, especially if it includes excavation and oil spill cleanup, can also adversely affect forest land.

Urban and Suburban Land Use. The impacts for these two types of land use would be similar, but probably more severe in urban areas. Interference in highly developed areas would be the primary impact of pipeline construction. Any residences, businesses, industries, schools, or traffic areas near the right-of-way would be affected. The impacts would include noise, dust, traffic congestion, hindered access, and visual discord. The developed character of urban and suburban lands would also slow down the construction rate, making the duration of impacts greater. The combined effect of these impacts could be serious considering the number of people exposed.

During pipeline operation, urban or suburban areas would be impacted only by maintenance or oil spills. Maintenance could create impacts similar to construction. Spills could create traffic hazard, fire hazard, potential for pollution of water and septic systems, and damage to homes, businesses, lawns, and gardens. If a domestic water system were polluted, oil-water separators may be brought to aid in clean up. In a single use area, such as rangeland, a spill would be contained and contaminated soil would be removed; by contrast, in an urban area, cleanup crews would have to rapidly contend with a number of hazards and several types of damage.

Development would be prohibited on the permanent right-of-way, possibly creating both a barrier to expansion of urban patterns and division of areas of common use. Extension of public services could be impeded and more expensive. If properly located within a development or community, the right-of-way could provide a greenbelt or open space.

Industrial Land Use. The industrial land use category includes utility and manufacturing plants, mining operations (see "Geologic Concerns and Mineral Resources," p. 53), and other heavy industry. The impacts of pipeline construction and operation on industrial land use would be site specific and similar to those for urban land use.

Impacts on Ownership

The effect of the construction and operation of the proposed pipeline would be much greater on small ownerships than on large holdings, regardless of use, because the area involved would be a greater percentage of the holding. Any postconstruction land-use restrictions would weigh more heavily. It can be assumed that small ownerships would be commonly encountered in urban fringes.

Linear Patterns

Associated facility sites represent irreversible land-use commitments. These installations could restrict expansion of transportation or utility corridors. It is possible that the corridor may be used by another utility if the pipeline is abandoned, which would result in long-term and possibly significant impacts.

Site Patterns

The impacts to site patterns could be very similar to those of specially managed areas and linear land uses.

TABLE 28. FEDERAL SPECIALLY MANAGED AREAS THAT COULD AFFECT THE ROUTING OF THE NORTHERN TIER PIPELINE

AREA CLASSIFICATION	CROSSING[1] PERMITTED	FORM OF ACTION REQUIRED	ENVIRONMENTAL STIPULATIONS	LEGAL REFERENCE[2]	REMARKS
U.S. Department of Interior, Bureau of Land Management					
Proposed wilderness and wilderness study areas	Yes			Federal Land Policy and Management Act of 1976	While a facility such as a pipeline generally is not permitted in a wilderness study area or an area proposed for wilderness designation, one could be authorized by congressional or executive order
U.S. Department of Interior, Bureau of Indian Affairs					
Tribal lands	Yes	Easement		25 CFR 161	Tribal council must grant permission; BIA must approve permission
U.S. Department of Agriculture, Forest Service					
Wilderness study areas	Yes	Permit		Forest Service policy regarding national forest management	
Sites and areas (either designated or eligible) on the National Register of Historic Places	Yes	Permit	Must not affect cultural-historical values	36-CFR 800.4	If the forest supervisor finds that the effect of a proposed project would not be adverse, a positive recommendation is forwarded to Director of the National Advisory Council on Historic Preservation

[1] "Yes" indicates that a crossing could be permitted, but it could also be denied

[2] CFR stands for Code of Federal Regulations. A reference such as 36 CFR 800.4 indicates title 36, section 800, subsection 4 of the codes

MEPA Concerns

Specially Managed Areas

A long-term impact would occur if specific qualities of these areas are diminshed, such as maintaining a cleared right-of-way through a near-pristine site. An oil spill in such an area could also cause a long-term significant impact.

Mitigating Measures

Location of the Pipeline and Associated Facilities

Potential adverse impacts to land use would be minimized by:

1) Identifying and avoiding, where possible, areas of small ownership.
2) Supplying proper and sufficient information to landowners to allow them to negotiate a suitable easement.
3) Avoiding specially managed areas. Where avoidance is not possible, crossing could be done in a manner

that preserves each area's special characteristics.

4) Permitting the smallest possible permanent right-of-way, thereby reducing land requirements.
5) Locating associated facilities where they would conflict the least with existing land use.
6) Avoiding urban and suburban areas.

Construction Practices

During pipeline construction, potential adverse impacts to land use could be reduced by:

1) Using the smallest possible construction right-of-way.
2) Segregating topsoil on both irrigated and dry cropland.
3) Constructing irrigation canal crossings only after harvest, especially when crossing major irrigation systems serving extensive downstream areas.
4) Maintaining a 24-hour construction schedule in areas where noise at night would not be a greater problem than interference during the day.
5) Mitigating particular impacts, such as noise, dust, and congestion, through techniques such as equipment muffling, construction-site watering, and scheduling to avoid rush hours and highly developed areas.

TABLE 29. MONTANA SPECIALLY MANAGED AREAS THAT COULD AFFECT THE ROUTING OF THE NORTHERN TIER PIPELINE

AREA CLASSIFICATION	CROSSING[1] PERMITTED	FORM OF ACTION REQUIRED	ENVIRONMENTAL STIPULATIONS	LEGAL REFERENCE[2]	REMARKS
Department of Health and Environmental Sciences					
Municipal Watersheds	Yes	Permit	Contamination of water sources prohibited	MCA 75-6-101 et. seq.	Montana's Safe Drinking Water Act prohibits the contamination of water sources but doesn't provide the department regulatory authority over siting or construction
Department of Fish, Wildlife, and Parks					
State game management areas	Yes	Easement		MCA 87-1-301, 305	If management areas would be severely affected, a pipeline crossing might be prohibited
State parks, monuments, recreation areas, fishing access sites, fish hatcheries	Yes	Easement		MCA 87-1-301	Pipeline crossing might be prohibited if an area would be adversely affected

[1] "Yes" indicates that a crossing could be permitted, but it could also be denied
[2] MCA stands for Montana Codes Annotated A reference such as MCA 75-6-101 indicates title 75, chapter 6, section 101 of the codes

SOCIAL AND ECONOMIC CONCERNS

The transitory nature of pipeline construction results in fewer social and economic impacts than those associated with other major construction projects. This is due to the limited amount of time nonlocal workers spend in an area, as well as the work schedule and the general characteristics of pipeline workers. Surveys of construction workers (Mountain West 1979b) have shown that pipeline workers average ten to twelve years older than construction workers on powerplants and coal mines and are accompanied by fewer dependents (0.3 per worker vs 1.3 per worker on other projects).

Nevertheless, the proposed pipeline would probably have some adverse impact on lodging, educational facilities, and health services unless appropriate mitigating measures are taken. Other adverse social and economic impacts not related to the work force could also be expected, including temporary losses in agricultural productivity, clearing of forested areas, noise- and dust-related disturbances during construction, and restrictions on future development in urban and industrial areas, particularly near Missoula and Helena. In the event of an oil spill, there also may be economic losses from the effects on agricultural productivity, on aquatic and wildlife populations, on land values, and on the quality of recreation sites.

On the positive side, the pipeline would generate for Montana around 375 person-years of temporary jobs, and nearly sixty permanent employment opportunities. Wages and local purchases of goods and services by construction contractors would result in substantial income benefits for Montana residents. Positive fiscal benefits would also result at the state and local levels from income and property taxes.

Public Attitude Survey

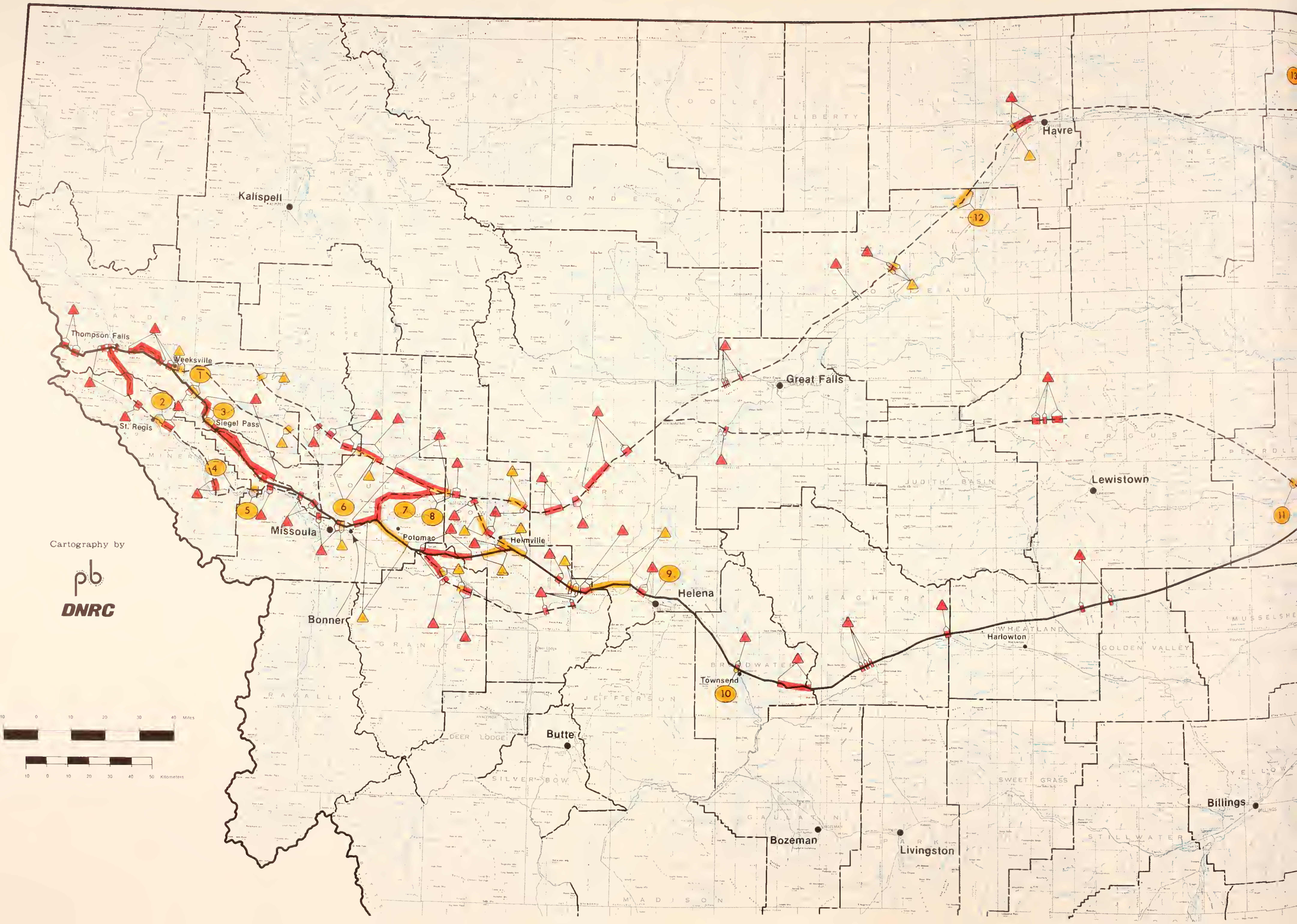
To assess the range of public opinion concerning the proposed pipeline and to identify other possible social and economic impacts, a survey was undertaken using the key respondent method. (Further details of this study are on file with DNRC.) This method is not a random opinion survey and does not profess to give representative public opinion of the project. The sample method is designed to reach individuals relatively well informed about a project, and is weighted heavily toward community leaders. The survey sample was restricted to respondents located within the potentially impacted counties and communities; therefore, it does not include representatives of groups that may have shown an active interest in the proposed pipeline at the state level.

General Themes

A number of general themes emerged concerning attitudes toward the pipeline. Predominant among these themes was overall approval of the Northern Tier pipeline. Seventy-one percent of the respondents were in favor of the pipeline being built in their locale, while only 7 percent were opposed. Because the survey sample included many community and county leaders who were active in local government and employed as professionals or business managers, some pro-pipeline bias could have been anticipated; however, respondents from other occupational categories also favored pipeline construction.

For the most part, respondents were not concerned about large groups of pipeline workers temporarily residing in their communities. There was little expectation of major social and economic disruption. However, some respondents did think that strain on existing facilities could occur, especially in the smaller communities. They felt that schools generally could handle the increased enrollments, that there would be little adverse effect on medical services, and that there would be only minor law enforcement problems, but that additional demands on water and sewer systems might cause problems, particularly in the summer. Residents of small towns, which would be the most vulnerable to significant social and economic impact from the project, were realistic in their expectation that only limited numbers of workers would ultimately reside in their areas. If adequate accommodations and services are not available, the majority of workers would not choose to live there.

MAP NO. FIVE



Thompson Falls
Weeksville
St. Regis
Siegel Pass
Kalispell
Missoula
Potomac
Helmville
Bonner
Helena
Townsend
Great Falls
Havre
Lewistown
Harlowton
Butte
Bozeman
Livingston
Billings
S A N D E R S
L I N C O L N
F L A T H E A D
L A K E
M I N E R A L
M I S S O U L A
G L A C I E R
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S I L V E R B O W
J E F F E R S O N
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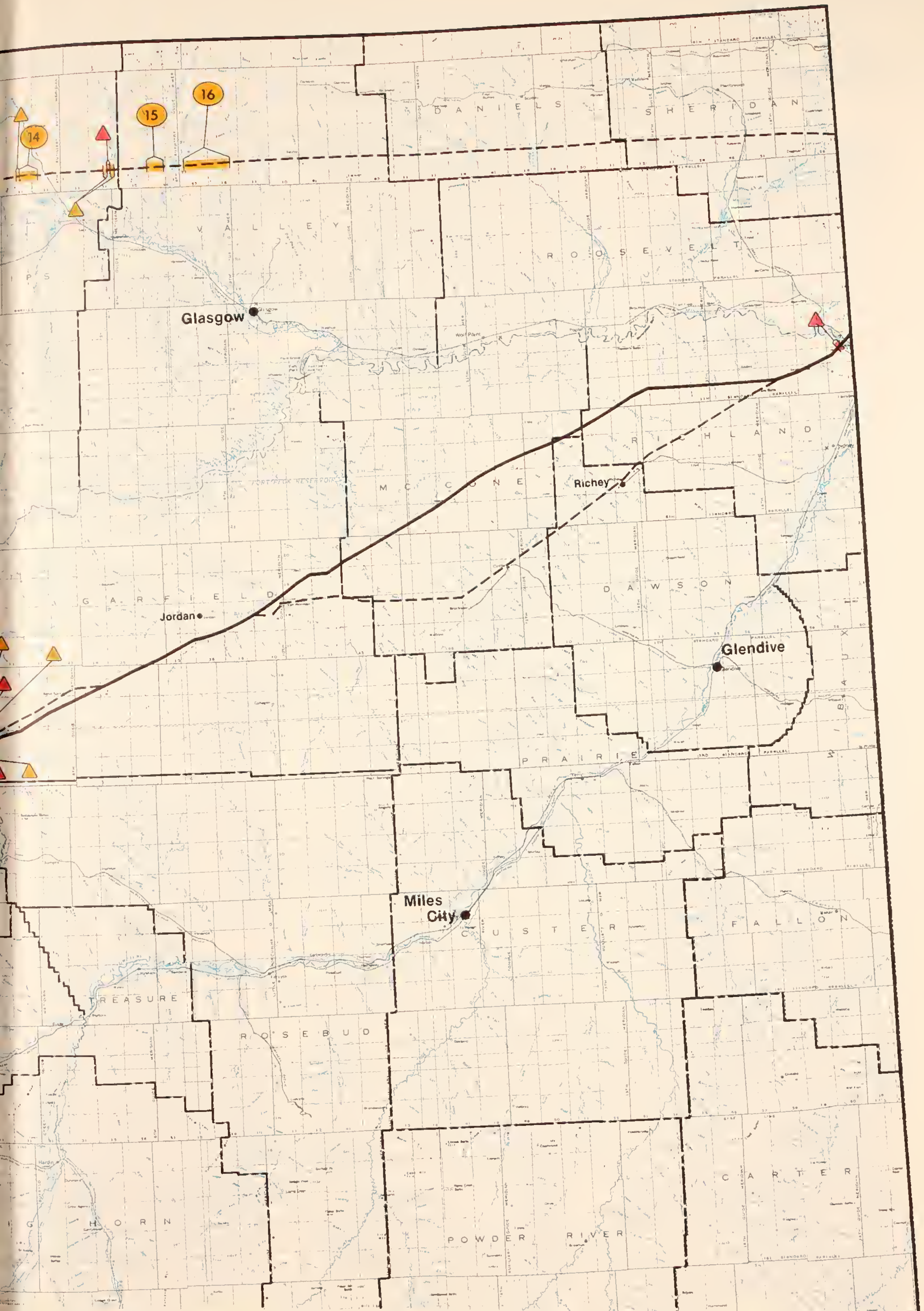


MAP NO. FIVE

VISUAL, RECREATION, AND SPECIALLY MANAGED AREAS

VISUAL IMPACTS

- Critical
- Sensitive

RECREATION AND SPECIALLY MANAGED AREAS

- Sensitive

NO.	NAME	AREA TYPE*
1	RARE II 1-794 Patrick's Knob North Cutoff	S.M.
2	RARE II 1-791 Cherry Peak	S.M.
3	RARE II 1-796 North Siegel	S.M.
4	Alberton	Rec.
5	Alberton Water Supply.	S.M.
6	South Fork of the Jocko Sacred Area	S.M.
7	Conservation Easement (administered by Nature Conservancy)	S.M.
8	Clearwater Game Range	S.M.
9	Helena Fairgrounds	Rec.
10	Canyon Ferry Wildlife Management Area	S.M.
11	BLM Wilderness Study #260 East Lonesome Lake	S.M.
12	BLM Wilderness Study #220 Cat Creek	S.M.
13	BLM Wilderness Study #303 Black Coulee	S.M.
14	BLM Wilderness Study #306 Garland Creek	S.M.
15	BLM Wilderness Study #355 Rock Creek	S.M.
16	BLM Wilderness Study #356 Bitter Creek	S.M.

*S.M.-Specially Managed Areas, Rec.-Recreation Areas

VISUAL, RECREATION AND SPECIALLY MANAGED AREAS

Respondents anticipated positive economic benefits from the proposed Northern Tier Pipeline. During the construction phase, such benefits were anticipated from employment opportunities for local residents and from increased income as a result of local expenditures made by NTPC and the pipeline workers. The large majority of respondents believed that local people would seek pipeline jobs and would find them. If only a few local people were hired, respondents still felt that the employment would be good. Respondents also felt that the pipeline project would induce other jobs in the community and that local residents would fill these jobs.

Over the long term, many respondents cited the positive economic benefits that the pipeline would represent in terms of assured fuel supplies for farmers and ranchers, and assured crude for Montana's oil refineries. Many respondents also anticipated the additional revenues that the pipeline would bring to the taxing jurisdictions through which the line would pass.

Land and land-use impacts did not emerge as a strong concern. Although a few respondents anticipated the possibility of significant adverse effects, about half expected no problems at all. They were particularly unconcerned about impacts during the construction period; however, a number of respondents did mention possible problems with right-of-way acquisition—problems that they felt could be overcome by policies of fair compensation and good public relations. A minority of respondents thought adverse impacts on land use would be a problem, but felt that avoidance of productive land was the major concern. The potential for oil spills was the primary concern mentioned of possible impacts during pipeline operation.

Lodging also emerged as a theme in the survey results. Respondents in most communities with populations larger than one thousand thought that there would be adequate space in motels, hotels, trailer parks, and rental housing to accommodate the influx of pipeline workers. If not, it was suggested that workers could bring in trailers, and places to park them could be found. In towns of less than one thousand, the general feeling was that it would be difficult housing a large number of workers. Respondents in these communities also felt, however, that they could and should have the opportunity to house some of the workers. Over half of the respondents (56.8 percent) were opposed to the use of special construction camps; in communities of less than five hundred, however, construction camps were favored.

Mitigation. Because respondents generally foresaw few social and economic impact problems resulting from pipeline construction, suggestions regarding possible mitigation were limited.

Lodging. The majority of respondents favored lodging workers in communities rather than in construction camps. There was little opinion in support of having rooms in private homes available to workers. The use of travel trailers was mentioned by some respondents as a means of accommodating excess demand for transient lodging facilities.

Land Use. Good construction methods and careful reclamation (cleanup following construction) practices were suggested by several respondents as a means of limiting negative land-use impacts.

Other. Public relations and information programs were seen as critical in obtaining full local cooperation for the project and in minimizing problems with right-of-way acquisition. Fair compensation for disruption and damages was a corollary recommendation voiced by respondents. In addition, policies to facilitate local employment on the project were recommended.

Misconceptions about the Project

For the most part, survey respondents reflected an accurate understanding of the Northern Tier Project and its likely implications for their communities. However, some misconceptions were apparent in responses to the questionnaires.

Significant Local Employment Opportunities. Given the skill and union requirements of the project, it is unlikely that significant employment opportunities would exist for local workers. Survey respondents were generally optimistic about possibilities for local employment.

Adequate Lodging. Respondents generally underestimated the transient lodging requirements of the construction work force.

Property Tax Benefits. Respondents generally had only vague conceptions of the tax benefits that the project would bring to local taxing jurisdictions, particularly in the less-developed counties. Moreover, some respondents believed that there would be no change or even that their taxes would increase as a result of the project.

Impacts

The most significant social and economic impacts would be those occurring during pipeline construction. Of these short-term impacts, housing would probably be the most adverse, while the fiscal effects would be the most beneficial.

The major impacts of pipeline operation would be the property tax revenues ($10.5 to $11.9 million per year with current mill levies) accruing to the counties crossed by the pipeline, state corporate income tax revenues, and increased costs of electricity to other users due to the way electricity is priced (see p. 63).

Abandonment would create many of the same adverse impacts as the construction phase, although for shorter periods of time. Agricultural land would be disrupted, and noise and dust nuisances would be present, but fewer impacts on lodging could be anticipated. There would be positive employment and income effects, although these would be less than during construction.

Population

Potential population impacts due to pipeline construction would depend on the construction schedule and would vary by month and location. Surveys of pipeline projects (Mountain West 1979b) indicate that few secondary employment opportunities are induced by pipeline construction. Any that are generated would likely be filled by local people. Thus, population impact estimates focus entirely on nonlocal construction workers and their accompanying families.

Two types of lodging impacts would occur, (1) a housing shortage for nonlocal workers of 54,000 to 168,000 person-nights, and (2) a conflict for housing between nonlocal workers and other transient populations, such as summer tourists and Canadian shoppers (see **Northern Tier Report No. 6**). Tourists are an important market for retailers in western Montana cities, and Canadian shoppers are an important market for retailers in Great Falls and cities along the Hi-Line; they are also a significant portion of the motel demand. Lodging shortages may influence their purchases from Montana retailers. The extent to which this would be counterbalanced by the pipeline workers' purchases is difficult to estimate.

Montana communities large enough to have transient lodging and which are within commuting distance of pipeline construction could expect varying population increases over a ten-month period. Communities just beyond commuting distance could expect to lodge nonlocals for short periods of time. Nonlocal population impacts lasting up to fourteen months, given current construction schedules, could be anticipated for particular communities within commuting distance of pump station and delivery facility sites. (See appendix G for specific examples.)

Although NTPC has not proposed to use construction camps, they may be appropriate mitigation for impacts in sparsely populated areas where lodging facilities are limited. Camps capable of lodging the work force for one section of pipeline are commercially available. These camps include sleeping units, kitchen facilities, recreational facilities, an infirmary, and a water and sewage system. Water is hauled in by truck. Camps are minimally staffed, but provide most worker needs. Investment costs are high—$5,000 to $6,000 per worker. These camps are further discussed in **Northern Tier Report No. 6**.

The Public Attitude Survey shows that, except in small communities, community leaders do not generally favor the use of construction camps, because camps would reduce or eliminate local purchases, including food and lodging. The decision to use camps or to depend on existing lodging facilities would probably be made by the prime contractor on each section.

Only a small number of employees would be required to operate the pipeline system.

Less than fifty direct permanent jobs are estimated, so impact to population would be negligible.

Public and Commercial Service Facilities
Because of the short-term duration of population influx, impacts on most public services and facilities would likely be minimal.

The impact on public schools would probably be insignificant because the number of school children anticipated does not exceed the capacity of the affected schools. The schools least able to handle more students are the smaller schools in sparsely populated areas. If construction camps were used in these rural areas, it would be highly improbable that there would be adverse impacts on educational services; workers' families cannot stay with them in construction camps and few workers would be likely to stay outside of the camps. Construction camps could also be appropriate mitigation for impacts on health services. A camp infirmary could minimize the impact on most outpatient services in rural areas.

Transportation
Transporting workers and materials along the route would involve a massive effort. Over a quarter of a million tons of materials would be moved to the pipeline route, and nearly 3,500 workers would commute to work sites throughout Montana at the peak of the project. Construction would progress from west to east on the five sections, lasting from two weeks to a month in any given location. The materials would be unloaded from boxcars and trucked to stockpile locations along the route. From each stockpile, the materials would be transported by truck to the construction spread as needed.

Traffic volumes would be affected in the vicinity of any particular location for about a month. Volumes would gradually increase until the pipe and other materials are transported to the location, recede slightly, and then peak as the construction progressed. The maximum traffic impact at any location would involve approximately 440 workers and fifty trucks delivering materials, going to and from each spread every day; up to 750 to 1,000 vehicle trips per day would be expected in the vicinity of a construction spread (NTPC 1978a, USDI 1979). This peak should last only two weeks at any given point, with traffic then returning to normal. The worst-case impact would arise by assuming that everyone commutes alone, thus causing 960 trips per day during the peak. If car pooling is encouraged or workers are bused from staging sites (common practice on pipeline projects) the actual impact could be considerably less. In any case, no irreversible impact is anticipated.

The volume of traffic generated directly by pipeline construction may cause hazardous driving conditions, particularly on narrow and winding roads. This was a major problem during TAPS construction when pipe sections were welded at marshalling yards and then hauled to the construction spreads in 24-m (80-ft) lengths on extra-long trailers (Dixon 1978). NTPC has indicated it does not plan to use this method. It is conceivable, however, that possible construction delays could result in NTPC using practices such as hauling double-length pipe to save time.

Secondary roads could be significantly impacted because many are unpaved with lower weight capacities and smaller traffic counts. County and state highway officials do not believe that the movement of NTPC materials and equipment across the secondary road system would cause problems such as damaged bridges, culverts, and cattle guards as long as the legal weight per axle restrictions are obeyed (**Northern Tier Report No. 6**).

While state and county roads almost always have legal load limits, there is virtually no enforcement on county roads. Gravel-surfaced and unsurfaced roads could suffer damage during the spring thaw; particularly vulnerable would be shoulders, cattle guards, and bridges. Pipeline construction companies usually maintain roads to keep construction going smoothly and can be expected to maintain standards required for other traffic.

Pipeline road crossings pose another potential impact to the transportation system. The method used depends on the requests of the agency with jurisdiction over the particular roads. Traffic impacts would be greater for trenched crossings than for drilled crossings (see chapter five, p. 40). There is a permit procedure for any construction affecting all state and some county roads. The permit has only a nominal fee, but obligates the contractor to assume damages and costs which might arise from construction. When authorities deem necessary, flagmen and inspections would be provided to supervise the road crossings. The construction contractor would be required to pay for these additional public costs, the repair of the roads, and future road maintenance costs caused by settling or inadequate patching.

Noise
Noise levels would increase during pipeline construction. As they affect people, noise levels are commonly expressed in terms of an A-weighted decible scale (dBA). (Table 30 shows decibel levels of typical noise sources.) Noise increases would be noticeable for residences within 760 m (2,500 ft) of construction. Depending on the

TABLE 30. DECIBEL LEVELS OF TYPICAL NOISE SOURCES

	dBA	Source
CONTINUOUS EXPOSURE CAN CAUSE HEARING LOSS	140	Threshold of pain
	·	
	·	
	130	
	120	Jet Takeoff (200 ft)
	·	Auto Horn (3 ft)
	110	Chainsaws, Noisy Snowmobiles (50 ft)
	100	Lawn Mower, Power Tools (3 ft)
	·	Noisy Motorcycle (50 ft)
	90	Heavy Truck (50 ft)
	80	
SPEECH INTERFERENCE	·	Quiet Snowmobile (50 ft)
	·	Busy Urban Street
	·	Quiet Motorcycle (50 ft)
	70	Normal Automobile
	60	Conversation (50 ft)
	50	Quiet Residential Area
	·	Library
SLEEP INTERFERENCE	40	Quiet Home
	30	
	20	
	10	Broadcasting Studio
	0	Threshold of Hearing

SOURCE: USDI 1979 (Modified from Washington State Department of Ecology)
CONVERSION FACTOR: 1 ft = .3048 m
NOTE: Decibels are logarithmic; therefore:

50 dBA is 10 times as intense as 40 dBA
60 dBA is 100 times as intense as 40 dBA
70 dBA is 1000 times as intense as 40 dBA

rate of construction progress, there would be a period of several days when the level would exceed 65 dBA within 150 m (500 ft) of construction (USDI 1979).

During the construction of a pump station, significant noise sources would be cranes, dozers, backhoes, tractors, and welding machines. Residences located about 460 m (1,500 ft) from the construction site would experience equipment noise levels of about 70 dBA. This would be a significant increase above background levels for rural locations, and might cause some annoyance. Residences located about 1,200 m (4,000 ft) from the construction site would experience noise levels of about 55 dBA. Most of the pump stations would be located away from residential areas.

Recreation Sites

A potential conflict could occur between nonlocal workers (living in recreation vehicles and campers) and tourists in state and national forest campgrounds, particularly in western Montana. The number of workers living in such quarters would probably be no greater than one hundred in any one area (**Northern Tier Report No.** 6). Relative to the capacity of the campgrounds, nonlocal pipeline workers would comprise a small proportion of total usage in summer. Since these facilities are for recreational use only, personnel would theoretically be barred from staying there while working on the pipeline. With proper warning by contractors and enforcement by campground supervisors, adverse impacts would probably not occur on public campgrounds. However, competition with regular tourists for hookups at private campgrounds during the summer months would be probable. For details on housing availability and demand, see **Northern Tier Report No.** 6.

Economic Impacts

The primary short-term, beneficial economic impacts would be an increase in income and employment. Local income would be increased by the construction payroll and local purchases required for construction. Since out-of-state workers send a significant portion of their paychecks home, the total income effect would not be the total payroll and an adjustment is therefore necessary. When local purchases by construction contractors are taken into account and added to the adjusted payroll, the estimated total income effect ranges from $150 to $156 million, depending on the route selection. For details on these calculations see **Northern Tier Report No.** 6.

The only short-term employment effects that can be predicted are those which directly result from pipeline construction. Montanans would probably be employed in 22 to 23 percent of the total jobs resulting from construction. This would be approximately five hundred jobs with an average duration of eight to nine months. (Employment is projected in person-year equivalents, i.e., one person employed for twelve months. Construction phase employment of Montana residents would range between 372 and 381 person-year equivalents out of a total 1,366 to 1,394 person-year equivalents.)

It is unlikely that many of the high-skill jobs would be held by Montana residents. (For a detailed discussion of this issue see **Northern Tier Report No. 6**.) For instance, few if any of the welding positions on the pipeline would be held by Montanans since Union Local 798 of Tulsa, Oklahoma, supplies all of the welders for unionized pipeline projects in the U.S. Montanans may be employed as welders' helpers or as welders for pump station construction. It is also probable that few of the supervisory staff or NTPC construction inspectors would be from Montana. Virtually all of the prime contractors large enough to handle a project of this magnitude are from outside Montana and would bring their supervisory staffs with them. Of the operating engineers employed, probably only 20 percent would be Montanans. Among teamsters and laborers, Montanans would constitute about one-third of the total hired in this category.

DNRC estimates that twenty-two of the forty-eight permanent jobs NTPC proposes in Montana would be held by residents of Montana. Induced employment is estimated at seventy permanent jobs, with half initially going to Montana residents (see **Northern Tier Report No.** 6). (Since the jobs are permanent, all employees would become residents of Montana.)

Along with the beneficial effects of income and employment, adverse short-term impacts of lesser economic importance would result from the temporary loss of agricultural and rangeland productivity during construction. Compensation for these losses and any related damages would be negotiable between the landowner and NTPC. For cropland, excluding an average 35 percent fallow, the total losses are estimated between $121,000 and $197,000. For rangeland areas, a high estimate of lost livestock production varies from approximately $40,000 to $61,000. These losses are low because the amount of affected land is not large: 700 to 1,240 ha (1,730 to 3,064 acres) of agricultural land and 1,280 to 2,000 ha (3,163 to 4,942 acres) of rangeland, depending on the route chosen.

The Northern Tier Pipeline would affect long-term land-use patterns in several ways. Depending upon the route, from 650 to 830 ha (1,603 to 2,058 acres) of forest land would be removed from current uses through the siting of mainline valves, pump stations, delivery facilities, access roads, and the right-of-way, as well as additional acreage from powerlines serving valves and pump stations. Of this, at least 590 to 770 ha (1,455 to 1,910 acres) would remain cleared during the life of the project.

Property Taxes. Property taxes would be the largest long-term fiscal impact of the proposed pipeline. The investment of approximately $400 million would significantly increase the tax base throughout the state and would have a particularly important effect in the more rural counties. The estimated 1981 NTPC property-tax payments statewide vary from $10.5 million to $11.9 million among the routes under consideration, based upon average 1978 rural mill levies. At the county level, these estimated NTPC tax liabilities range from 0.2 to 81.2 percent of 1978 revenues.

The appraisal value of NTPC would depend upon, among other factors, the profitability and market value of the company, which are difficult to quantify. Because of this inherent uncertainty, two alternative scenarios of long-term tax impacts have been calculated. Both assume constant tax rates. The conservative approach assumes that the income and market value of NTPC would not increase throughout its life and that a straight-line depreciation of its assets would be allowed by the tax assessors. Based on current mill levies, the results indicate that NTPR would pay from $164 to $176 million in Montana property taxes during the depreciable life of the pipeline. A less conservative approach assumes the value of the firm would increase sufficiently to compensate for the depreciation associated with the pipeline operation. Thus, this scenario assumes that the value of NTPC would remain constant over its life. The results indicate that NTPC would pay $319 to $361 million in Montana property taxes over the depreciable life of the pipeline (based on current mill levies). The actual tax payments arising from this pipeline project would probably lie somewhere between these two extremes. Thus, a substantial increase in local revenues would result if local taxing jurisdictions hold tax rates at present levels. If local expenditure levels were held constant, with the added tax base of the pipeline, local mill values would rise and mill rates fall; NTPC would take over a share of current tax levels and reduce taxes for other taxpayers.

Corporate Income Taxes. Montana taxes the net income of corporations at 6.75 percent; net income is defined by a three-factor formula based on Montana's proportion of sales, property, and payroll. BLM, in its draft EIS for the proposed pipeline, gives two sets of estimates that NTPC might receive for the transport tariff per barrel (USDI 1979). One is based on an 8 percent return on investment, while the other is based on a 12 percent return. Each varies depending upon the ultimate destination of the crude oil. The actual tariffs charged would depend upon rulings of the regulatory commission. Therefore income and corporate income tax revenues are difficult to quantify at present.

Personal Income Taxes. Montana income taxes would be paid on the total gross construction payroll earned in Montana and on all the induced income generated by construction activities. The total income is multiplied by Montana's average tax rate, 3.5 percent, to obtain the estimated income tax. The total estimate of income tax

revenues from pipeline construction is approximately $5.5 million, over the construction period.

Electrical Costs. The pumps along the pipeline in Montana would require approximately 132 to 139 MW of electrical generation. The growth of electrical demand in the state will be met primarily through construction of coal-fired generating plants, which are considerably more costly than existing generating facilities.

Electricity rates are determined by the Public Service Commission and in the past have been based upon average costs of service to each class of customers. If this basis for pricing continues, NTPC's payments for electricity would not cover the additional costs of those suppliers providing the electricity. For example, if new coal-fired generation costs $0.035 per kilowatt hour, and if the average cost of all generation is $0.01/kwh, and if other costs of supplying electricity to NTPC were negligible, then an average-cost-based pricing method would result in a revenue deficiency in Montana of $9.2 million per year when Northern Tier is operating at 113,000 m^3/d (709,000 bpd) and $20.2 million per year at 150,000 m^3/d (933,000 bpd). In an average-cost-based pricing method these revenue deficiencies would be compensated by increased charges to all other customers. This could be avoided through the use of a pricing method based on marginal cost.

Contingencies

Events could occur that would alter the projected social and economic impacts of the proposed project during construction. Among these are a delay in construction start-up beyond March 1980 and the simultaneous construction of the Northern Border Pipeline which would cross approximately 300 km (180 mi) of eastern Montana.

Delay in Construction Schedule

The impacts identified above assume that construction of NTPC's pipeline would begin in Februray 1980. Should construction begin later than February, implying peak activity levels later than April, it is likely that two construction seasons would be required because of the difficulty and expense of winter construction.

If the startup date is delayed into the summer months, there would be less conflict with tourists in Missoula and Helena and more conflict in small, western Montana communities. Should the start-up date be delayed into autumn, a greater conflict with tourist lodging demands would occur in small western Montana communities, while the same level of conflict would occur in Missoula and Helena.

No significant change in the levels of impact on health services and educational facilities would result from a delay in start-up.

Northern Border Pipeline

The Northern Border Pipeline (NBP) is proposed as part of a system which would ultimately transport natural gas from Prudhoe Bay, Alaska, to Ventura, Iowa. As proposed, the NBP route runs from Canada through Phillips, Valley, and Roosevelt counties in Montana. As with the Northern Tier Pipeline, the entire length of NBP is proposed to be constructed simultaneously, with 600 workers per section. As of early 1979, the construction of the NBP was scheduled to begin in 1981 or later. Should NBP and the Northern Tier Pipeline be constructed simultaneously, several effects in Montana can be expected.

Labor. If the pipelines were concurrently constructed the pipeline companies would compete nationally for skilled labor (particularly welders) and locally for semiskilled and unskilled labor. It is probable that the supply of welders available or interested in working in the Northern Tier states during the entire construction season would be inadequate for both projects to be carried out simultaneously within the current time frame. The supply of local labor in eastern Montana and western North Dakota is already extremely tight due to oil and natural gas development activities. Therefore an even higher share of the workforce would have to be imported from outside the region.

The possible consequences of the reduced available labor for NTPC's project are:

1) Fewer workers per construction section and therefore more time required to complete the work
2) Higher wages required to attract and hold workers; therefore, greater cost
3) Higher turnover of labor because of competing employment opportunities
4) Disruption of other economic sectors as local workers shift to more lucrative pipeline jobs

Services. Simultaneous construction of both pipeline projects in eastern Montana would place an even greater strain on already over-taxed transient lodging facilities. This would result both from the greater number of nonlocal workers seeking lodging and from the fact that the inevitably slower construction pace would result in lodging needed for longer periods of time. Education and health facilities would be similarly strained.

MEPA Concerns

Most of the social and economic impacts from the pipeline would last only as long as the construction period. Impacts associated with the influx of workers, the increased traffic, and noise from construction would be short term. Significant impacts lasting over the life of the project would include the beneficial fiscal impacts resulting from the increased local tax base and the adverse impacts resulting from the increased cost of electricity to other customers associated with the use of average-cost-pricing for pumping electricity.

Most resources used during pipeline construction would be irretrievably committed. This includes the labor and the time spent by construction machinery, as well as fuel and most of the materials used in construction. Some materials could be salvaged when and if the project is abandoned, depending on the cost of the salvage and the market value of the materials.

Electricity used in pumping would be irretrievably committed to the project, as would the coal used to generate the electricity. Capital equipment built to provide the electricity may not be irreversibly committed; if there is a continued growth in demand for electricity and the pipeline is abandoned, the equipment could be used by others.

Mitigating Measures

Potential adverse impacts to social and economic concerns would be mitigated by:

1) Contacting mobile home court and campground owners and encouraging them to temporarily add space to accommodate the influx of construction workers.
2) Encouraging homeowners to rent out rooms.
3) Using student rental housing when available.
4) Using construction camps in sparsely populated areas. An infirmary could be included to minimize impacts on health services.
5) Providing emergency evacuation services in counties where acute-care services may be pushed beyond capacity.
6) Busing workers to construction sites.
7) Permitting hauling of double-length pipe only where it would not cause hazardous conditions.
8) Obtaining a written agreement prior to construction between the contractor and each relevant highway or road authority delineating responsibility for maintaining and repairing roads, bridges, and cattle guards.
9) Getting authorization from the Public Service Commission for a marginal-cost-based rate for pumping electricity. This could partially or totally eliminate impacts on the electrical costs of other classes of customers.

CULTURAL RESOURCES

Cultural resources are the physical evidence left from prehistoric activities or important historic events. They also include the location of recorded historic events with no surviving physical evidence. The value of a cultural resource site, (the immediate environment of the cultural remains) is the potential information of a past society's way of life which is retrieved from

analyzing the relationship of the remains and related environmental factors. Therefore, each site has a unique potential for significance and must be considered a finite, nonrenewable resource (Schiffer and Gumerman 1977).

Federal statutes require federal agencies to work in conjunction with state agencies to inventory and evaluate cultural resources prior to undertaking actions which may affect these resources. The identified cultural resources are evaluated according to established criteria of the National Register of Historic Places. The Montana State Antiquities Act and MEPA also require that cultural resources be considered and evaluated when major state actions might affect them.

Cultural resource data currently available for the areas within the study corridors have been gathered from many different research investigations and sources, but no systematic inventories have been done. The cultural resource sites known to exist within the proposed areas merely indicate where archaeological and historical work has been conducted to date, and they in no way represent the total numbers and locations of sites which may actually be present. Therefore, until an inventory is done to obtain complete and accurate data, an evaluation cannot be made.

Impacts

The significance of a site is evaluated in terms of its use in understanding the past or in maintaining the quality of the existing and future environment. A site may be significant at a local, state, or national level. Until systematic investigations are completed for the proposed pipeline areas, all known sites should be considered significant.

For unknown sites, the following worst-case impacts may occur. During the planning stage, crews would conduct a survey of the route. They would likely encounter both known and unknown cultural materials. There could be site disturbance resulting in displacement, damage, or destruction of cultural resources. These same impacts could also be expected during construction activities such as clearing, trench excavation, and backfilling. Activities associated with road construction and storage yard preparation would have the same effects. There could also be other impacts unrelated to actual construction activities. For instance, increased access by construction personnel may be associated with site vandalism. Cultural materials may be removed, damaged, or destroyed by souvenir hunters and vandals. Noncultural destructive processes such as erosion or chemical alterations in the soil may be accelerated and cause the same effects. Increased access to the areas during operation and maintenance of the proposed pipeline may also result in these impacts.

MEPA Concerns

Sites potentially have unique and nonrenewable values. The loss of a site would be an irreversible loss of the opportunity to learn more about some aspect of human history or prehistory. The significance of this depends on the site's qualitative value. Proper excavation of a previously unknown site may be considered a positive impact.

Mitigating Measures

After a comprehensive inventory of cultural resources has been done, evaluation for inclusion in the National Register of Historic Places may begin. To comply with Section 106 of the Historic Preservation Act (1906), both the Advisory Council on Historic Preservation and the State Historic Preservation Office must be consulted about the appropriate protection or preservation of cultural resources listed or eligible for listing in the National Register of Historic Places. If known sites cannot be avoided or preserved, excavation of the resources would be the best alternative.

VISUAL QUALITY

Components of the visual resource considered in this study are vegetation, topography, water, and manufactured objects.

The visual environment along the proposed Northern Tier Pipeline routes ranges from mountainous, densely forested areas in the west to plains and grasslands in the east. Most of western Montana is densely forested with narrow valley bottoms. The terrain varies from steep mountains to rolling pastures and farmlands. Dense coniferous forests are found along mountainsides and in the higher elevations, with ponderosa woodlands in the lower open areas. Overall, the area is high in scenic quality. The natural landscape of eastern Montana, also highly scenic, contains semiarid rangeland and considerable rough terrain, as well as rolling uplands, scattered buttes, broad, shallow stream and river valleys, and local badlands.

Impacts

Assessment of visual impacts involves two major considerations. First, in forested areas a significant long-term visual impact would be caused by regular maintenance clearing of trees and shrubs along the permanent right-of-way (see map 5, p. 58). This impact would continue through the operating life of the line and for a decade or more after line abandonment until vegetation is reestablished. Second, a significant but short-term visual impact would result from construction and continue through the reclamation period along the entire line. Destruction of vegetation, generation of dust, and operation of machinery in scenic areas are examples of short-term visual impacts.

River Crossings

River crossings would pose special visual problems which would largely depend on the construction method used. At trenched crossings, which are proposed at all rivers by NTPC, wider-than-normal rights-of-way would have to be cleared on either side of the river for equipment operation and temporary storage of excavated materials. Some of the visual impacts during this crossing operation would be sediment in the water and landscape deterioration of the banks and staging areas. Sediment generation would be roughly proportional to the amount of material excavated from the river bottom and the total digging time. At some crossings, sediment would degrade the visual quality of the river for kilometers downstream. This visual impact would be short term and relatively insignificant in comparison to the damage which the trenched crossings could inflict on aquatic life (see "Aquatic Life and Habitats," p. 68). Long-term impacts would range from insignificant to major if extensive riprapping and related bank disturbance occurs.

There would be no massive instream excavation or disturbance with aerial crossings (see chapter five, p. 41), but a highly visible, above-ground structure would be installed. A free-span suspension bridge (with towers approximately 90 m (300 ft) high) would obviously be a significant visual impact if located in a scenic area. The impact would be for the life of the project and, because of their height, little could be done to screen the towers from view. Similar but much smaller suspension bridges are used on the 25-cm-diameter (10-in-diameter) Yellowstone Pipeline crossings of the Clark Fork near Bonner, Plains, and Thompson Falls; the bridges are highly visible.

A pier crossing would resemble a conventional highway bridge but would, in general, be slightly less conspicuous (see chapter five, p. 41).

A pipeline crossing using directional drilling would have the least adverse visual impact of any crossing method (see chapter five, p. 40). Because the banks are not disturbed, there would be no need for riprap or other artificial armoring protection (Congram 1978). Besides short-term damage to the staging and drilling areas, visual quality would be impacted by the catchment basins constructed at both ends of the bridge.

Associated Facilities. Pump stations and delivery facilities built in nonurban areas could be visually intrusive; the exact sites of these facilities are not yet known. There would also be visual impact along any new access and maintenance roads, and along new electric transmission and distribution lines. Each valve would require a distribution line, usually parallel to and within the

permanently cleared right-of-way. There would be little or no adverse visual impact from providing power to the valves. Because they could be supplied at distribution voltage, the pole structures would be small and not highly noticeable. The 69- to 230-kV electrical transmission lines to the pump stations would probably be single-pole, wooden structures which would cause little visual impact. There would, however, be adverse visual impact where new rights-of-way were opened for the powerlines, especially in forested land.

MEPA Concerns

The overall short-term visual impacts would be moderate during the construction period but, in most cases, would rapidly diminish to negligible. The long-term visual impact on rangeland depends largely on the probability of successful recovery of the original slopes and vegetation. In the worst case, reclamation could take five to eight years on dry sites and on those with poor soils (see **Northern Tier Report No. 1**). The trenched area would probably remain visible even after there is a good plant cover, because the specific plants and the percentages of ground covered would not be the same as in areas adjacent to the right-of-way. This would be a long-term, minor-to-moderate impact that is highly site-dependent.

Nonforested, flat areas with deep, productive soils and negligible erosion rates would generally revegetate in less than five years (see "Vegetation and Land Productivity," p. 78), rapidly reducing visual problems to negligible levels. For example, the Yellowstone Pipeline right-of-way cannot easily be identified on the ground in cropland or flat-to-gently rolling rangeland, except where soils are poor and precipitation low.

In badlands and on slopes with fragile soils, there is a high potential for creation of unsightly gullies and ravines on the right-of-way. The visual impact in these areas is, perhaps, less significant than the actual damage to soils and plants as well as possible sediment pollution problems; but visual considerations are, nonetheless, worthy of attention.

The long-term visual effect in forest lands would be the most significant impact. All of the possible routes go through many stands of dense timber, much of it second growth on land logged twenty or more years ago. A linear strip of deforested land would be visible wherever a road crosses the right-of-way, producing a narrow "tunnel view." Viewed from the side, trees generally would screen the cleared right-of-way. The cleared right-of-way would be readily visible from the air, however, and would be more obvious than a typical logging road because it would be wide and straight. The 5-m (15-ft) difference between the construction and the permanent rights-of-way could be reclaimed, thus slightly reducing the visual impact over a period of some years. It is difficult to project a recovery period for forest land after abandonment of the pipeline, although the time would certainly be no more than approximately twenty years in high-precipitation areas.

Mitigating Measures

Visual impacts would be mitigated by following the general guidelines on pp. 232 to 240 of "Proceedings of the First National Symposium on Environmental Concerns in Right-of-Way Management" (Downey 1976).

Location of the Pipeline and Associated Facilities

Adverse visual impacts would be reduced by:

1) Avoiding long, straight stretches during centerline selection in forest areas, thus reducing the tunnel effect.
2) Selecting pump station and delivery facility sites which would blend with the surrounding landscape, and retaining trees and shrubs where possible. Landscape architects could be consulted.

Reclamation

During reclamation, impacts to visual quality would be minimized by:

1) Planting clusters and strips of shrubs and low trees on the edges on the right-of-way, making the change from cleared land to forest less abrupt.
2) Planting screening shrubs wherever roads cross the right-of-way. This could be done on all but a short distance, possibly 9 m (30 ft), directly over the pipe. Federal regulations require an open space so that aerial checks of the right-of-way may be made; however, a necessary width is not specified (see "Permanent Right-of-way," chapter five, p. 46). NTPC could also consider planting narrow strips of shrubs and trees over the entire width of the right-of-way at road and stream crossings.
3) Restoring and revegetating riverbanks and the surrounding areas to their original condition whenever possible.

SOILS

The general distribution of soils in Montana is shown in figure 16, p. 66. Western Montana has a frost-free season ranging from 50 to 110 days, precipitation ranging from 36 cm (14 in) to greater than 127 cm (50 in) per year, highly varied parent materials, and gentle to extremely steep slopes. Erosion potential in western Montana varies because of different ranges of climate, topography, and parent materials. Soils on gentle slopes in foothills and valleys have low erosion potential, and form in relatively homogeneous parent materials where there is a longer frost-free season and less precipitation than in the mountains. Almost all the steep slopes in the western mountains have high erosion potential. In some cases, highly erodible parent materials increase erosion potential. For example, lake silt and clay found along the Clark Fork near Missoula are highly erodible.

Soils in the valleys of western Montana, such as those soils developed on alluvial fans and stream terraces, are similar to the grassland soils of eastern Montana. They generally have thick, dark surface horizons and a relatively high nutrient content (figure 16, map unit G). Many forest soils in mountains have a surface litter layer covering a leached horizon. The leached horizon may overlie a clay or sodium-rich horizon that is relatively rich in nutrients. These soils correspond with map unit A in figure 16. Some soils in western Montana have little or no horizon development. Their textures relate closely to parent material because they are little weathered (figure 16, map unit F). Soils found at or above timberline (figure 16, map unit B) are generally slow to form, and highly dependent on maintenance of a vegetation cover to prevent soil erosion.

Soils in eastern Montana include both fertile, dark grassland soils and soils typical of arid or semiarid climates (figure 16, map units G and H). The water found in arid soils may be alkaline or saline, or chemically bound to soil particles and thus not available for plant use. Leached surface layers, with subsurface layers enriched in clays, soluble salts, or carbonates are common. Soils on geologically young landforms (such as valley bottoms and glacial landforms) may show little or no horizon development (figure 16, map unit F); other soils have early stages of horizon development (figure 16, map unit E).

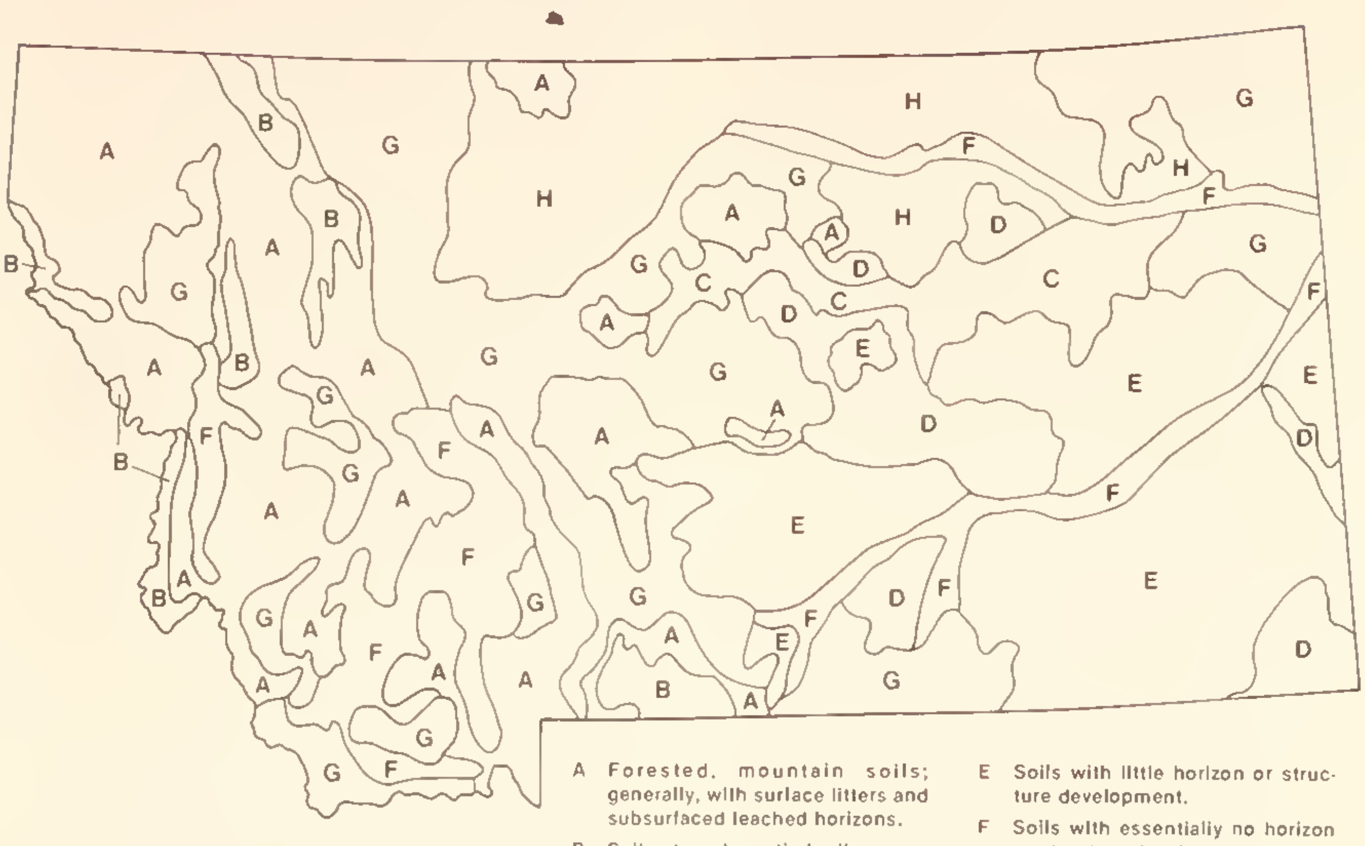
Eastern Montana has a precipitation range between 25 and 50 cm (10 and 20 in) per year, a frost-free season between 100 and 135 days, gentle slopes, and little variation in parent material within any given area (relative to the mountainous western Montana).

Slope and parent material are the major influences on erosion potential. In badlands and "potential" badlands areas (figure 16, map units C and D), erosion potential generally is high even where the area is not extensively dissected.

Impacts

Adverse impacts of the pipeline and associated facilities would include soil loss, decreased fertility, mixing of soil horizons, and compaction. Some adverse impacts may increase the potential for others. For example, a decrease in fertility caused by horizon mixing might slow revegetation and significantly increase erosion rates. Areas of high impact risk to soils are shown on map 4, p. 48.

FIGURE 16. DISTRIBUTION OF SOILS IN MONTANA



A Forested, mountain soils; generally, with surface litters and subsurfaced leached horizons.
B Soils at or above timberline.
C Areas dominated by rough gullied land.
D Areas dominated by fine-textured shallow to moderately deep soils over shale.
E Soils with little horizon or structure development.
F Soils with essentially no horizon or structure development.
G Grassland soils; generally thick, dark surface horizon.
H Dry climate soils; generally with leached surface horizons.

Source Southard 1973

Soil Loss

The loss of soil, particularly topsoil, by wind and water erosion may be accelerated by stripping vegetative cover, increasing runoff, increasing slope gradient or length, mixing soil horizons, compacting soils, or contaminating the soil with oil. By far the most severe problems would occur during pipeline construction when large areas of the right-of-way and other construction sites are devoid of vegetation. Water discharged from hydrostatic testing may erode soil if settling ponds and other mitigative measures are not used. Leaks may also cause local erosion at points along the pipeline during testing. Wind erosion may contribute significantly to soil loss during winter months, particularly in eastern Montana.

Access roads used during maintenance and operation of the pipeline may present erosion hazards throughout the life of the pipeline, though with proper maintenance these can be largely controlled.

Oil Spills

Oil spills onto soils may reduce infiltration; decrease fertility and productivity; increase microbial activity; alter pH; decrease aeration; increase the fire potential; cause changes in soil color, temperature, and structure; and reduce wettability.

Artificial fills, such as those along pipeline trenches and building foundations, are generally more permeable than the material removed. Fills provide little resistance to oil migration and tend to direct oil flow (USDI 1976). Thus, leaking oil would generally work its way upward to the surface soon after the leak begins (see "Ground Water," p. 77). Surface flow of oil would depend primarily on the physical and chemical properties of the oil, local topography, soil permeability, vegetation cover, and weather.

Local topography would significantly control the shape of the oil flow and thereby the areal extent of the spill. A spill on level terrain would tend to be circular, but a spill on a slope would tend to be elongated with a relatively short leading edge and little lateral movement. Downhill flow would primarily be dependent on the terrain and the leakage rate. When oil flow from the pipeline rupture stops, surface flow would slow.

Oil would continue to spread until it reaches natural depressions or until the oil is absorbed or friction of the ground cover overcomes the spreading. The type of vegetation an oil spill encounters would affect its rate of flow and extent of spreading. For instance, a spill passing over relatively barren ground would flow and spread at a more rapid rate than a spill flowing over heavily vegetated ground. In areas where there is thick moss, shrubs, or trees, the oil would adhere to the vegetation (McKay and Mohtadi 1975).

McKay and Mohtadi quantitatively predicted the flow rate of oil on an inclined surface. Density of the oil, flow width, oil film thickness, viscosity, and slope of the surface were considered. For example, a spill of Prudhoe Bay crude oil at 38 degrees C (100 degrees F) at a rate of 1,590 m^3 (10,000 barrels) per hour on a slope of 5 degrees and a flow width of 61 m (200 ft) would spread at a rate of about 0.9 m per second (3 ft/s). Thus, the 38 degree C (100 degree F) oil would travel about 3 km (2 mi) in one hour. Vegetation, terrain, ground temperature, and soil type could change this flow rate. (Oil in the proposed pipeline would be considerably less than 38 degrees (100 degrees F). See "Thermal Effects," p. 67).

The extent of spreading on ice largely depends on the roughness and permeability of the ice and viscosity of the oil. The U.S. Coast Guard has developed a method to predict the areal extent of an oil spill based on the parameters described above. As an example, 1,590 m^3 (10,000 barrels) of oil would spread into a roughly circular spill with a radius slightly over 0.16 km (0.1 mi).

Snow retards the spread of oil by absorption and lowering of the oil temperature. It is likely that spills on snow would not flow as far as spills on land.

On wet soil, oil floats and accumulates in surface depressions, but in dry soil it sinks downward and laterally. Soil wettability, infiltration capacity of the soil, and the structure of the soil determine, in part, the extent to which oil ponds on a soil surface (Rowell 1977). An oil coating on soil particles reduces soil wettability, occupying space which might otherwise contain air or water.

In dry soils, oil penetration may result in a boggy, barren area. Soils penetrated by oil to a depth of roughly 1.2 m (4 ft) are usually impermeable to rain. In general, plant damage and revegetation problems result from insufficient moisture and air, although insufficient fertilizer nutrients may also limit growth.

Rowell (1977) found oil could increase or decrease the soil pH. Thus, oil spills may inhibit plant growth by creating alkaline or acidic soil conditions.

Plant roots physically break up oil-saturated soils, while litter and decaying roots contribute to buildup of soil humus. Thus, soils impoverished in nutrients to begin with would have few plants reestablished after a spill. The oil would also persist in the soil. This is to some extent countered by increased microbial growth in oil-contaminated soils. This results because oil increases the carbon-nitrogen (C:N) ratio in the soil which, in turn, favors increased metabolism of microbes (McLaughlin et al. 1974).

Darkening of the soil by spilled oil would increase absorption of radiant heat and increase soil temperature. Increased microbial activity after spills would partially result from increased soil temperature since microbes are, to some extent, temperature-dependent (Westlake et al. 1974).

Volatilization of some oil components may increase the potential for fire, which may kill soil microbes important to oil decomposition, soil aggregation, and plant growth. Burning oil during cleanup operations may

release toxic gases into the environment and leave a tarry surface crust (Toogood 1977).

Soil Compaction

Soils traversed by heavy equipment along the pipeline route during construction and operation would be compacted. Easily compacted soils may be irreversibly altered.

Compaction increases bulk density and may decrease pore volume by 10 percent in the upper 26 cm (10.4 in) (Voorhees 1977). Seventy percent of the compaction may occur within the first five passes of equipment, and the maximum dry density change may occur between 12 and 30 cm (4.8 and 12 in) below the surface (Raghaven et al. 1977). Reduction in pore volume may reduce the infiltration rate and the availability of moisture to plants, increase runoff and erosion, and reduce the moisture-holding capacity of the soil. Plants in compacted soil are less efficient in nutrient and water uptake because they generally have increased root diameter, and decreased root length, surface area, and root penetration depth (Kulkarni and Savant 1977). However, in excessively drained soils, reduced infiltration and permeability caused by compaction may favor plant growth by retaining more water.

Horizon Mixing

NTPC proposes to use double ditching during excavation of the pipe trench; topsoil would be stored separately from subsoil. Thus, within the topsoil, all horizons would be irreversibly mixed. This mixing would also happen during excavation of sites for the pipeline and associated facilities. All layering, such as any sedimentary beds of the subsoil in the trench would also be mixed. When horizons are mixed, changes in porosity, permeability, infiltration rates, and pH may adversely affect plant growth or erosion potential. Mixing horizons may increase plant exposure to toxic salts. Rangeland soils are particularly sensitive to these adverse effects. Mixing horizons may however, increase soil fertility by bringing nutrients to the surface.

Thermal Effects

The temperature of the oil may reach 70 degrees F upon discharge from pump stations. (NTPC maintains heat input at the pump stations is not significant (NTPC 1979d).) As it flows through the pipe, the oil should approach soil temperature but probably would be warm enough to melt snow where the pipeline is within 0.9 m (3 ft) of the surface. The distance (down-flow from a pump station) over which snow melt would occur is not known. The increased snow melt and resultant runoff might increase the rate and amount of erosion but no information is available about the magnitude or significance of these adverse effects. (See "Vegetation and Land Productivity," p. 79, for further discussion of thermal effects.)

MEPA Concerns

Soil Loss by Erosion

This would be most significant during construction and during the early stages of reclamation, when ground cover and erosion-control measures are not complete. Soil erosion would be a minor but long-term problem on maintenance roads and on thin soils which are highly saline or alkaline, or nutrient-poor soils.

Standard erosion-control measures may have to be supplemented in problem areas with repeated checks and follow-up such as reseeding and repair of erosion-control structures. Soil erosion by wind would be a minor, short-term problem if mitigated properly, as would erosion from water discharged or leaked during hydrostatic testing.

Damage to Soils by Oil Spills

The significance, magnitude, and duration of soil impacts due to oil spills would depend on many factors. These include the size of the spill, depth of oil penetration, type of oil, soil texture and chemistry, terrain, potential use of the land, and temperature. In general, significant short-term damage (as described above) to soils in large areas could occur. Appropriate and timely mitigating measures would reduce long-term effects to low but not negligible levels. These measures would be expensive and require conscientious followup reclamation measures, and possible replacement of topsoil in severely damaged areas.

Soil Compaction

Although easily-compacted soils may be irreversibly compacted by heavy machinery, compaction damage to some soils would be short-term, primarily during construction, and mitigable by appropriate use of machinery. Lacking details on soils and construction sites, predictions of the amount and effects of irreversible or long-term damage cannot be made.

Horizon Mixing

Horizons in topsoil would be irreversibly mixed at all excavation sites for the pipeline and associated facilities. In a small but significant number of areas, plant growth would be hindered or erosion rates increased. At most sites, with appropriate reclamation measures, horizon mixing would be a negligible problem.

Mitigating Measures

Locating the Pipeline and Associated Facilities

Adverse effects of the proposed pipeline on soils would be minimized by:

1) Including soils and reclamation specialists as part of the centerline and surveying teams to ensure that engineering and design decisions include soils and reclamation problems.
2) Mapping soils where Soil Conservation Service information and other soils maps are incomplete or inadequate. For much of Montana, there in no up-to-date soils information at the detailed scale needed.
3) Avoiding sensitive areas such as wet areas, steep slopes, water courses, forests, compactable or erodible soils, and areas subject to wind erosion, when locating access roads and pipeline facilities.

Construction Practices

Potential impacts from construction practices would be mitigated by:

1) Storing topsoil separately from subsoil for the length of the line during trenching. This would aid in rapid reclamation. The soils information gathered as described in (1) above could be used to determine the specific depths to which topsoil was excavated along the pipe trench.
2) Keeping construction of new roads to the absolute minimum.
3) Never using streambeds as a source of materials for construction or sediment-control structures, except possibly for water diversion structures when streams and small rivers are crossed. Qualified biologists and geomorphologists could be consulted to judge the severity of the environmental impact. (See **Northern Tier Report No. 1** for additional measures concerning material sites.)
4) Minimizing operation of heavy machinery in streams and areas of water-saturated soils.
5) Doing a thorough cleanup and repeating it if necessary.

Reclamation

During reclamation, adverse impacts to soils would be mitigated by:

1) Rapidly reestablishing a vegetative ground cover. To expedite early revegetation, all cut-and-fill slopes which would not be disturbed during construction could be seeded and mulched at two-week intervals as they are completed, and could be later reseeded.
2) Including site-specific mitigation in NTPC's reclamation plan after the final route is selected.
3) Including repeated checks and followups, such as reseeding and repair of erosion-control structures, under the supervision of qualified soils and reclamation specialists as part of the erosion control and reclamation techniques. In Montana, nets, chemical binders, and mulches are commonly effective only if followup repair or correction is done.
4) Including provisions such as land restoration and access in the right-of-way easements purchased by NTPC. NTPC could take the initiative in informing each landowner of the options which could be used in restoration and

reclamation, or other professional advice could be made available to landowners wherever soil or reclamation would be difficult.

5) Giving special attention in the erosion-control and reclamation plans to minimizing impacts during wet periods, when soils are highly susceptible to erosion. Unauthorized cross-country travel and development of unauthorized roads could be prohibited during construction.
6) Including specific mitigation in NTPC's reclamation plan for the potential severe wind erosion during the winter months in eastern Montana.
7) Considering reclamation complete when a plant cover equal to or greater than 90 percent of that on similar undisturbed land adjacent to the disturbed area is established; this could be achieved in five years or less, unless unusually adverse weather conditions occur during the reclamation period. Adequate restoration could be ensured if NTPC's reclamation plan detailed a procedure for measuring percentage of plant cover for a statistical sampling of route segments differing in climate and soils. The actual field measurements of revegetation success would be rapid and cost-effective if efficiently designed.

Oil Spills

In the event of an oil spill, adverse impacts would be mitigated by:

1) Identifying emergency access roads in advance and avoiding, where possible, such sensitive areas as wet areas, steep slopes, water courses, forests, compactable or erodible soils, and areas subject to wind erosion.
2) Reclaiming areas after cleanup and doing followup checks for several years. Special attention could be given to:

   a) Replacing topsoil if removed or if damaged by fire. Special attention could be given to measures for soil replacement and restoration in shrub and grass steppelands in eastern Montana.

   b) Making rapid establishment of vegetative cover a major reclamation goal.

   c) Reclaiming roads and work sites near the spill.

   d) Recontouring or filling in excavated areas as appropriate to the area.

   e) Using special erosion-control techniques, such as mulching, if standard reclamation procedures fail.

   f) Reestablishing streambanks, channels, and bottom gradient and sediments, where affected by the cleanup operation.

   g) Cultivating land compacted by equipment.

3) Using temporary bridges or fill ramps to cross waterways rather than cutting into streambanks.
4) Using helicopters where spill cleanup does not require large machinery and where access involves crossing or working in wetlands or other sensitive areas where soils or stream environment might be severely damaged.
5) Coordinating excavation for fill or riprap with the local conservation district with the advice of DFWP, DHES, and DSL.
6) Holding construction of new roads to the spill site to the absolute minimum and keeping each work site to a minimum.
7) Flagging the location of temporary roads rather than blading or grading them when temporary roads across flatland are necessary.
8) Constructing sediment-retention basins where sediment from cleanup operations or access endangers waterways.
9) Using streambed material for building spill control structures only when necessary to prevent additional severe environmental damage. It would be preferable that biologists be consulted to judge the relative severity of potential impacts.
10) Including the removal of all litter and debris in the cleanup operation after the spill has been contained and the contaminated soils are removed. Cleanup could be subject to the approval of the landowner. Combustible wastes could be removed rather than burned, unless done with small fires and the previous approval of the landowner and appropriate governing agencies.
11) Removing all signs of cleanup and restoring the area to as natural a condition as possible, subject to the desire of the landowner.
12) Taking special care when oil spills occur in cool months. Oil-oxidizing microbes are partially temperature-dependent and less active during cool periods. When spills occur in cool weather, black plastic placed over the spill may increase soil temperature sufficiently for optimum microbial activity. Fertilizer applications to establish a 10:1 or 15:1 C:N ratio would assure an adequate nutrient supply (Gudin and Syratt 1975).

AQUATIC LIFE AND HABITATS

The routes under study cross a variety of streams and aquatic habitats (see map 6, p. 70). Some of the most highly regarded trout streams in the United States are in western Montana. Eastern Montana streams include many with important warm-water habitats; others, because of their high sediment loads and naturally low water quality, are less important fisheries. Although water in eastern Montana is generally of lower quality than in western Montana, it is highly valued because of its scarcity.

Certain fish species are of special concern (as identified by DFWP) in Montana because of their limited gene pools or habitats. The primary species of concern that may be affected by the pipeline are pallid sturgeon, paddlefish, westslope cutthroat trout, upper Missouri cutthroat trout, and creek chub. In addition, dozens of game and forage fish species of recreational and scientific importance are found near the prospective stream crossings. Brown (1971) provides distribution maps of Montana fish species and life history information that could influence the timing of pipeline construction.

Aquatic invertebrates and plants are also important biological components of aquatic habitats. Aquatic invertebrates are the primary food sources for fish, and aquatic plants are important for photosynthesis; both are indicators of physical and chemical changes in the aquatic ecosystem.

Impacts

Petroleum Pollution

Oil contamination of waterways is potentially the greatest impact of the proposed pipeline. During pipeline construction, contamination could result from leaks of oil or hydraulic fluid from defective machinery, overturned equipment, refueling overflows, careless disposal of oil during servicing of equipment, leaking fuel bladders, and fuel line leaks. The discharged hydrostatic test water and the water used to flush the abandoned pipe would also be sources of oil contamination. During operation, leaks contaminating waterways could be major.

Petroleum products could harm aquatic organisms by: (1) acting on the body and gill surfaces of fish and invertebrates, thereby interfering with respiration; (2) coating and destroying algae and other plankton; (3) coating lake or stream bottoms, destroying bottom organisms, and interfering with spawning areas; (4) increasing microbial activity, thereby deoxygenating the water; (5) coating water surface, thereby interfering with photosynthesis and preventing reoxygenation of the water; and (6) having toxic effects on aquatic organisms. In addition, oil may be ingested by fish and taint the flavor of the flesh.

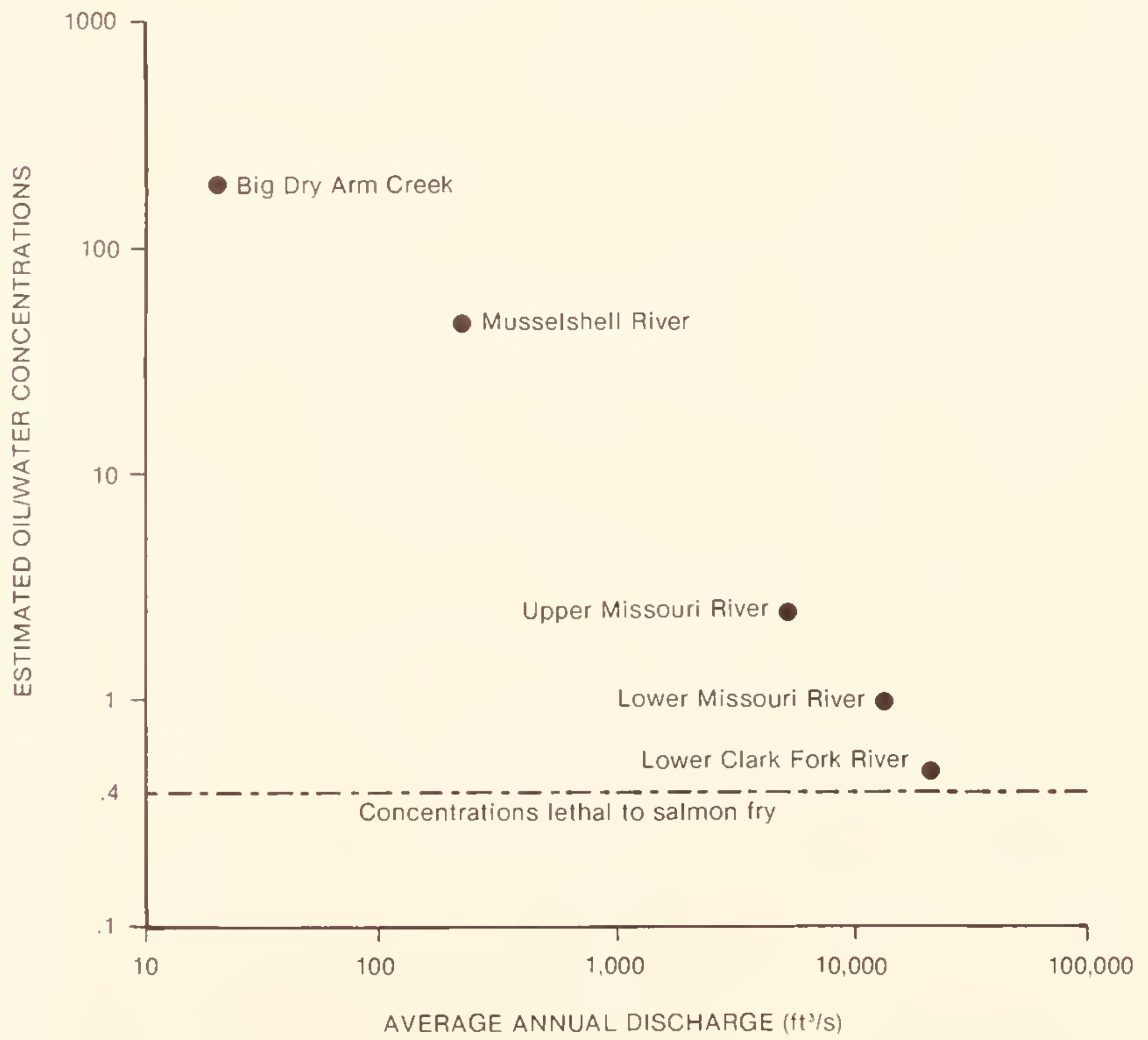
The chemical and physical properties of crude oil or other petroleum products would influence the severity of impacts of an oil spill. Certain components of crude oil, primarily the lighter-weight aromatic compounds, make oil toxic to aquatic organisms. Alaska Prudhoe Bay crude oil has a high aromatic content, making it highly toxic to organisms.

The minimum-sized oil leak that could be detected automatically by Northern Tier's proposed leak detection system would be approximately 556 m^3/d (3,500 bpd). Based on toxicity studies, spills of this amount into streams would result in oil concentra-

tions lethal to salmon fry in streams with flow volumes up to 16 m^3/s (570 ft^3/s) (see **Northern Tier Report No. 3**). Concentrations of oil expected in waterways in Montana if a maximum spill occurs and concentrations lethal to salmon fry are compared in figure 17. Warm-water fish species, macroinvertebrates, and plankton would also be intolerant of oil spills (see **Northern Tier Report No. 3**).

Low oil concentrations can affect the taste of fish. Tainting has occured with 10 L (2.6 gallons) of outboard motor oil and gasoline per acre-foot of water, demonstrating the need for concern over very small construction-related spills (see **Northern Tier Report No. 3**).

FIGURE 17. OIL CONCENTRATIONS ASSOCIATED WITH OIL SPILLS AT SEVERAL MONTANA LOCATIONS[1]



Conversion 1 ft^3/s = .02832 m^3/s

[1] All amounts are based on the BLM maximum spill size estimates at these particular crossings and an arbitrary time of one hour allowed for oil to leave pipe and enter the river

The specific effects of oil spills to the aquatic environment are difficult to assess. They would depend on the location of containment basins, volume of the spill, rate of entry into a stream, streamflow, stream gradient, season and location of the spill, type of stream bottom, natural degradation processes, and effectiveness of cleanup.

Cleanup of oil in Montana's aquatic environments would be most difficult in fast-moving, mountain streams. Cleanup of slower-moving streams through prairies also would present some difficulties. Lakes and reservoirs would generally be easier to clean up than running water. Oil spilled underground in flood plains would be difficult to detect and clean up and could continue to drain into streams for some time.

Information on crude-oil toxicity indicates that oil components most toxic to aquatic life are those that would evaporate or break down the fastest. Thus, while little could be done to prevent immediate toxic effects of a spill, there would probably be no long-term toxic effects. If an extensive fish kill were to occur, however, it would take several years for the population to recover regardless of the toxicity of remaining oil. The carbon compounds with large molecular weights would be more persistent than those with small molecular weights. While these heavier compounds are not as toxic as the aromatic compounds, they can adversely affect aquatic life over the long term. The severity of impact would depend on the effectiveness of cleanup procedures, as well as natural degradation and flushing.

Information on the natural rate of removal of oil from different types of stream bottoms and streambank areas is scarce and applies to small spills. Generally, oil is still detectable after a year in the area of a spill (**Northern Tier Report No. 3**). Large rocks may become coated with oil, but will be cleaned by turbulence in a short period. Fine sediments or organic material may mix with oil and form a long lasting mat.

Sediments

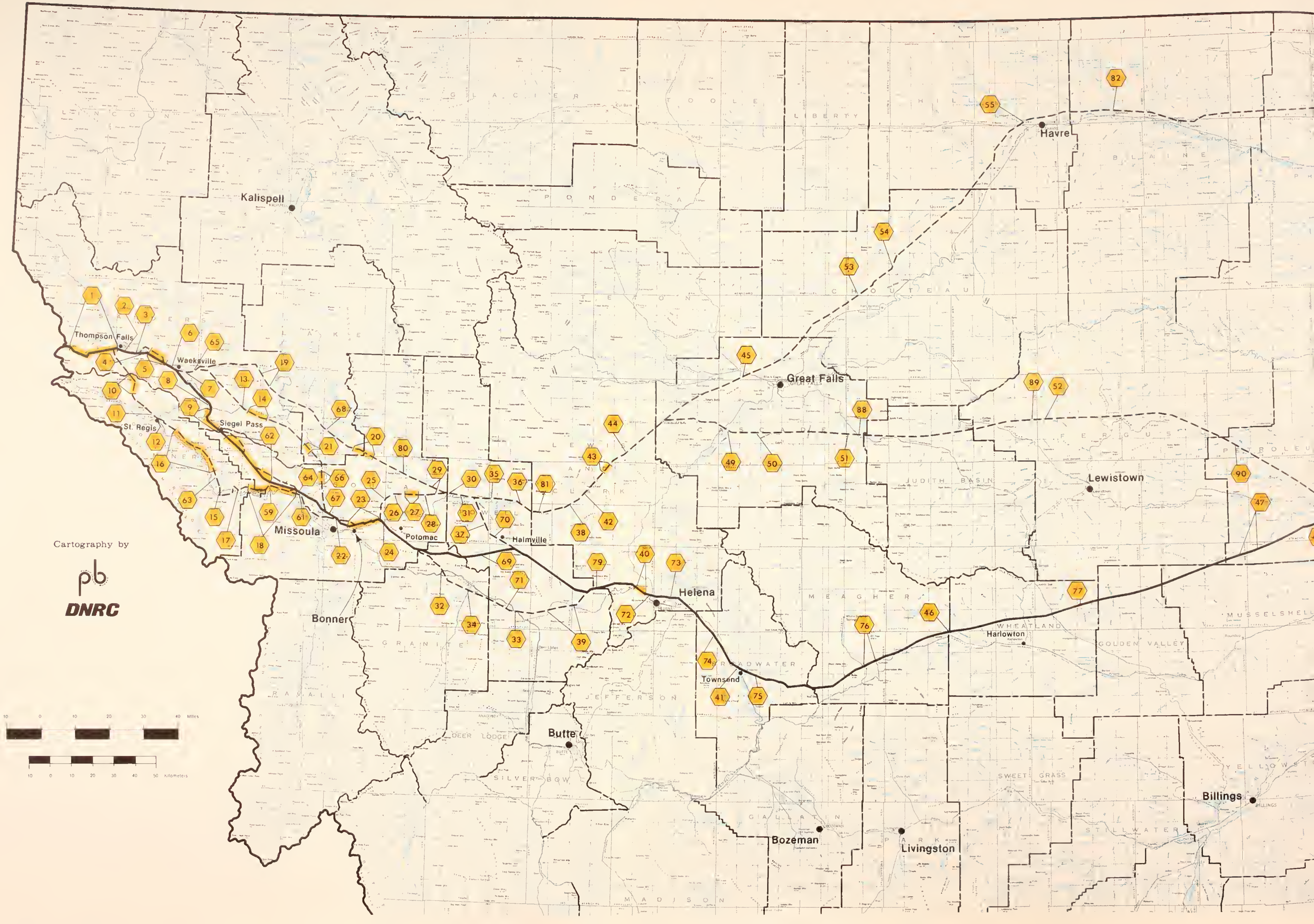
During construction of the pipeline, runoff from construction sites would increase stream sediment loads as would construction of river crossings (especially using conventional trenching methods) and access roads, excavation of sites for gravel, dirt, stone, or other material, and construction or wash out of culverts, bridges, or fords. If not controlled, water discharged during hydrotesting could also erode ground and wash sediments into waterways.

The effects of sedimentation on aquatic biota would, during construction, normally be most severe at sites immediately downstream from trenched river crossings. Generally, these sediments would be flushed out during the first spring runoff; however, in small streams of low gradient these sediments may not be flushed out for several years. Additional sediment from increased bank erosion, runoff from unstable construction sites, and downstream movement of clay, silt, and sand could have a less apparent, but long-term, effect on aquatic biota. Sediments could be washed downstream for several years, eventually settling in places such as lakes or reservoirs.

Effects on Primary Producers. Suspended sediment can affect primary production by reducing light penetration into water and by scouring the algae from the substrate. Silt or sand in waterways can settle on the stream bottom, reducing suitable conditions for algae. A reduction in primary production would decrease growth of higher organisms. The effects would be most detrimental where river crossings or disturbed surface areas were not stabilized, because the increased turbidity of rivers and reservoirs would continue.

Effects on Aquatic Invertebrates. The adverse effects of sedimentation on invertebrate populations have been well-documented under experimental and natural situations (see **Northern Tier Report No. 3**). Sedimentation could alter or eliminate aquatic invertebrate populations both through displacement and direct mortality. The extent of damage to invertebrate populations would depend upon many variables, including population levels and species present before sediments were introduced, and the condition of the stream bottom. Studies have shown that coarse-grained sediment (cobble, gravel) is the most productive stream bottom for organisms that are desirable food sources for fish populations (see glossary for

MAP NO. SIX



Kalispell
Havre
Great Falls
Lewistown
Helena
Missoula
Butte
Bozeman
Livingston
Billings
Townsend
Harlowton
Thompson Falls
Weeksville
St. Regis
Siegel Pass
Potomac
Helmville
Bonner
G L A C I E R
T O O L E
L I B E R T Y
H I L L
B L A I N E
L I N C O L N
F L A T H E A D
P O N D E R A
C H O U T E A U
T E T O N
L A K E
L E W I S A N D C L A R K
C A S C A D E
J U D I T H B A S I N
F E R G U S
P E T R O L E U M
M E A G H E R
W H E A T L A N D
M U S S E L S H E L L
G O L D E N V A L L E Y
G R A N I T E
R A V A L L I
D E E R L O D G E
J E F F E R S O N
B R O A D W A T E R
S I L V E R B O W
G A L L A T I N
P A R K
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Y E L L O W S T O N E
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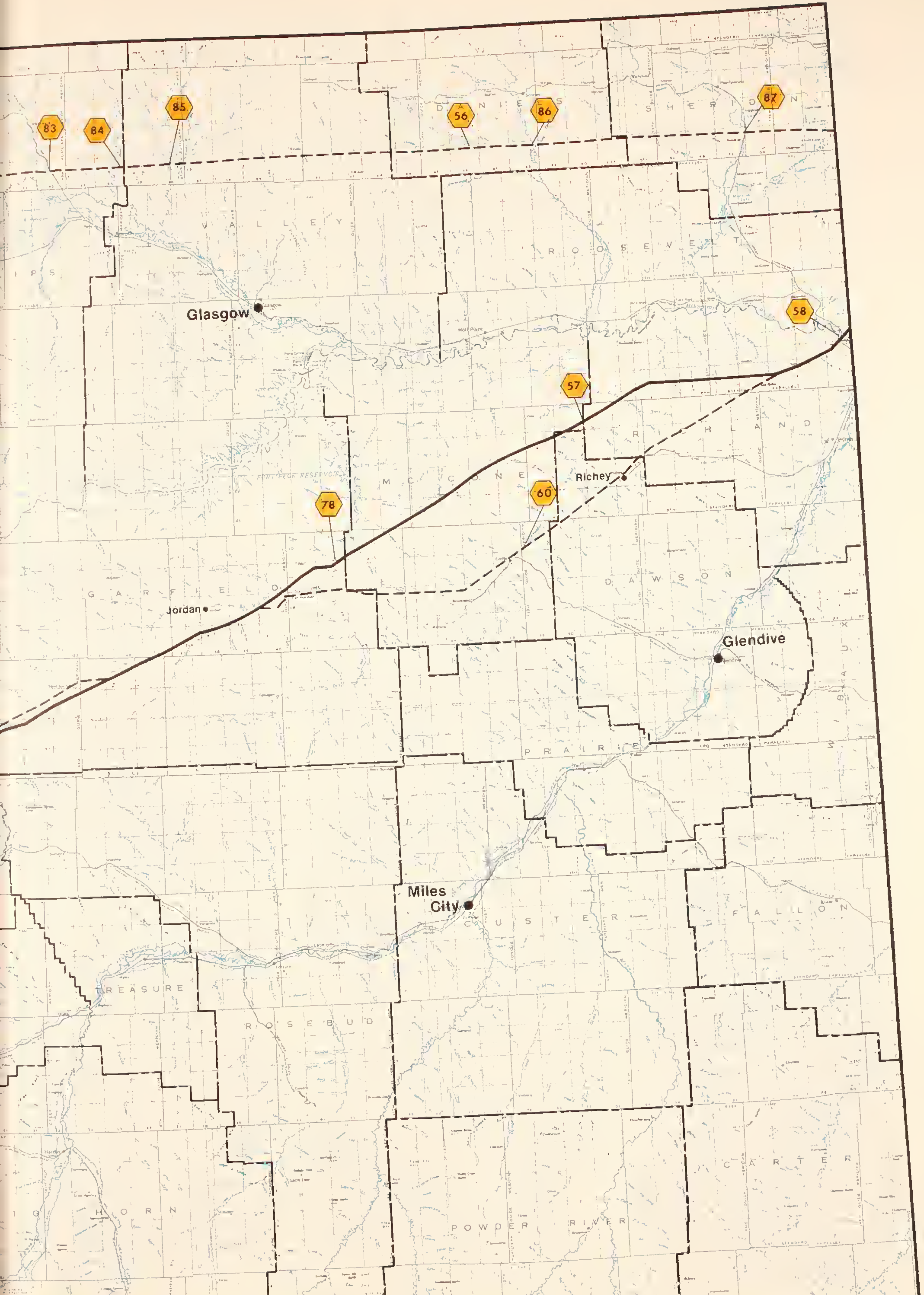


MAP NO. SIX

AQUATIC LIFE AND HABITATS

Sensitive Area

NO.	STREAM**	DFWP STREAM CLASSIFICATION
1	Prospect Creek (multiple crossings and closely paralleling)	4
2	Clark Fork	3
3	Thompson River	2
4	Clark Fork	3
5	Clark Fork (closely paralleling)	3
6	Clark Fork	3
7	Clark Fork	3
8	Clark Fork	2
9	Siegel Creek (multiple crossings and closely paralleling)	4
	Clark Fork (closely paralleling)	4
10	Twelvemile Creek (multiple crossings and closely paralleling)	3
11	St. Regis River	2
12	Clark Fork	2
13	Flathead River	3*
14	Flathead River (closely paralleling)	3*
15	Clark Fork	2
16	Clark Fork (closely paralleling)	2
	Flat Creek	4
	First Creek	4
	Second Creek	4
	Deep Creek	4
17	Clark Fork (closely paralleling)	2
18	Clark Fork (closely paralleling)	2
19	Little Bitterroot River	3*
20	South Fork of the Jocko River (multiple crossings)	4*
21	Jocko River (closely paralleling)	3*
22	Rattlesnake Creek	3
23	Blackfoot River (closely paralleling)	1
24	Blackfoot River	1
25	Gold Creek	3
26	Belmont Creek	3
27	Blanchard Creek (closely paralleling)	3
28	Blanchard Creek	3
29	Clearwater River	2
30	Cottonwood Creek	3
31	Monture Creek	3
32	Clark Fork	2
33	Clark Fork	2
34	Flint Creek	3
35	North Fork of the Blackfoot River	3
36	Arrastra Creek	3
37	Blackfoot River	2
38	Landers Fork of the Blackfoot River	3
39	Little Blackfoot River	3
40	Sevenmile Creek (multiple crossings)	4
41	Missouri River	1
42	Alice Creek	3
43	Middle Fork Dearborn River (multiple crossings)	4
44	Dearborn River	3
45	Sun River	4
46	North Fork Musselshell River	3
47	Flatwillow Creek	4
48	Musselshell River	3
49	Missouri River	2
50	Smith River	3
51	Belt Creek	3
52	Judith River	3
53	Teton River	3
54	Marias River	3
55	Milk River	3
56	West Fork Poplar River	3
57	Redwater Creek	3
58	Missouri River	1
59	Ninemile Creek	3
60	Redwater Creek	3
61	Mill Creek	3
62	Beecher Creek	4
	Burnt Fork Creek	4
	Soldier Creek	4
	Camp Creek	4
	Big Blue Creek	4
	Little Blue Creek	4
	Pine Creek	4
	Marion Creek	4
	Butler Creek	4
	Stony Creek	4
63	Nemote Creek	4
64	Mill Creek	3
65	Lynch Creek	4
66	Finley Creek (crossing and closely paralleling)	4
67	Grant Creek	4
68	Mission Creek	4*
69	Douglas Creek	4
70	Douglas Creek	4
71	Gold Creek	4
72	Tenmile Creek	4
73	Prickly Pear Creek	4
74	Beaver Creek	4
75	Deep Creek	4
76	South Fork of Smith River	4
77	Careless Creek	4
78	Big Dry Creek	4
79	Dog Creek	4
80	Boles Creek	4
81	Beaver Creek	4
82	Lodge Creek	4
83	Whiteriver Creek	4
84	Frenchtown Creek	4
85	Rock Creek	4
86	Poplar River	4
87	Big Muddy Creek	4
88	Big Otter Creek	4
89	Wolf Creek	4
90	Box Elder Creek	4

*These streams were not classified by DFWP but were estimated to be in the same class as similar streams.

**Unless otherwise specified, each map number represents a single stream crossing.

AQUATIC LIFE AND HABITATS

description of grain size). When stream conditions permit sand, silt, or clay to accumulate, the interstices of the coarse-grained bottom are filled; invertebrate forms that are adapted to fine-grained sediment (sand, silt, clay) habitat become established, replacing forms that are a source of food for fish. The new forms are generally less accessible as a food supply for fish. If mortality and displacement were great enough to represent a major loss of food for the fish in a stream, the productivity of resident fish populations could be decreased.

Most authorities agree that if fine-grained sedimentation is short-term, localized, and not excessive, the density and diversity of aquatic insect populations before increased sedimentation will be restored through recolonization of the affected area by migrating populations from unaffected upstream areas.

Effects on Fish. Results of experiments show that suspended sediment can injure or kill fish (see **Northern Tier Report No. 3**). The severity of the impacts would depend on a number of variables, including the species, age, and general health of the fish; the quality of water considering factors other than suspended sediment; the length of exposure to sediment; and the particle size, shape, hardness, and frequency of introduction of sediments. In most cases, indirect damage to fish populations result from: destruction of the food supply, eggs or larvae; displacement due to avoidance; or changes in habitat probably occur long before adult fish are directly harmed.

Mortality of fish eggs caused by sedimentation is well-documented (see **Northern Tier Report No. 3**). Clean, permeable gravels provide nursery areas for fish embryos; fine-grained sediment settling on the bottom during the incubation period can reduce the survival rate of developing embryos by clogging the pore spaces between the gravels. The species most adversely affected are the salmonids; however, other species also suffer from high levels of sediment in streams. Instances of high egg mortality associated with increased sedimentation have been recorded for species of fish which lay their eggs on surfaces, for example, yellow perch.

After eggs have hatched, accumulated sediment can be a physical barrier to movement of fry, trapping them and preventing them from emerging. Also, fry depend on the crevices and interstices in stream bottom gravels for cover from predators. An accumulation of fine-grained sediment can fill these spaces, eliminating escape cover; increased vulnerability to predators would contribute to increased fry mortality.

Fish also are repelled by instream disturbance and will avoid high levels of suspended solids. Fish displaced by high suspended solids would come into competition with fish already inhabiting other areas causing stress and possibly mortalities. The condition of a stream bottom or substrate can be an important factor limiting fish productivity. Adult fish populations can be seriously affected when sediment accumulations fill important pool areas, reducing available cover.

Recovery of fish populations would be slower than that of invertebrates.

Alteration of Streambed and Channel

Streams develop a delicate balance between variables such as: channel width, depth, gradient, and roughness; water velocity and rate of discharge; and sediment load and size of sediment debris. Channel morphology is influenced by the natural tendency of most streams to meander and the resistance to meandering provided by stream bank soil and vegetation. The interrelationships among these variables are such that a change in one variable will lead to a change in the others. Stream organisms are adapted to the existing balance in a stream, and will be affected if that balance is upset. Also any change can accelerate erosion or deposition of sediments, creating sedimentation problems as a stream adjusts to the change. Relocation of stream gravels harms eggs and benthic invertebrates.

Construction activities in the stream and on streambanks could upset a stream's equilibrium. If it would be necessary to straighten stream channels to accommodate the pipeline or structures for access roads (such as bridges or culverts), adverse effects on aquatic habitats would result. Also if cutting off stream loops or meanders were to occur, this would increase the gradient of a channel, reduce pool frequency, increase water velocity, and likely increase erosion of banks and stream beds.

Following the installation of pipeline crossings or drainage structures, stabilization and restoration of banks would be important. Bank or bed instabilities would increase the long-term levels of suspended sediment in water and possibly lead to a channel change or exposure of the pipeline. Bank stabilization is a long-term hydrogeologic concern. Manufactured bank-stabilization procedures, such as riprapping, create additional environmental impacts. Artificial structures can alter the natural hydraulics of a stream by changing stream bank roughness which directly affects stream velocities. Manufactured structures introduce additional instability into a hydraulic system and could adversely impact aquatic resources in the long-term.

Long-term hydrogeologic changes could also be induced by drainage structures (culverts, bridges, and fords) on access roads. Drainage structures may be undersized or partially or completely blocked by ice, debris, or beaver dams. Also, culverts can be crushed when improperly bedded or insufficiently covered; they can also be misaligned. It has been the experience of DFWP that many of the adverse impacts associated with road construction in Montana have resulted from undersized or improperly installed culverts (DFWP 1979). (See photograph below). Water accumulates above such structures and erodes the bed below them, resulting in perched culverts; material eroded from the bed is, in turn, deposited downstream. Such structures can also result in workpad and access-road washout. Instream depostion of the washed-out gravels can form "French drains" (deposits that are formed when a stream channel is filled by gravels, rocks, or cobbles without any fine-grained sediments). Such deposits may let water flow below the ground surface before emerging as surface flow further downstream. French drains can also form when poor grading at fords or pipeline crossings leaves elevated or widened stream channels.

Blocked Fish Passage

Fish movement could be blocked during construction of pipeline stream crossings by the temporary damming, diversion, or fluming of streams. High concentrations of

TAPS Photo by Charles Kay

PERCHED CULVERT

suspended sediment caused by construction of crossings could disrupt spawning migrations. More permanent blockages could occur if trees and branches cut during right-of-way clearing fall into streams and form "jams" at places such as culverts. French drains would block fish passage for long periods of time, as could large ruts that might form at fords. Long-term blockage of fish passage would also occur where inadequate drainage structures or channelized streams created excessive flow velocities. Perched culverts are a condition that can block fish passage. If oversized drainage structures caused water to spread out over a wide area, the resulting shallow water could also block fish passage.

Unrestricted passage of fish in streams is essential to the maintenance of wild fish populations; passage is most critical during fish migration. Blockage of streams could

prevent use of important spawning drainages and result in population declines. In many cases, small tributary streams provide most of the spawning habitat for fish from mainstem rivers; for example, the Clark Fork's fish population below Missoula is supported mainly by spawning in tributaries. In addition, fish kills could be induced by barriers blocking out-migration of fish to deeper water during freeze-up, or when summer low flows, drought, or irrigation withdrawals reduce or eliminate surface streamflow. Blocked fish passage during summer low flows also could kill fish by preventing them from escaping high temperatures in shallow water.

Destruction of Cover

Streambank vegetation, midstream logs and rocks, and undercut banks provide essential hiding cover for fish and habitat for food organisms. Right-of-way clearing and river-crossing construction could reduce this cover. Fish populations could decrease in areas where cover is removed.

Alteration of Stream Discharge

The removal of a large amount of vegetation from a watershed can alter existing streamflow patterns. Pipeline construction would not involve removal of the amount of vegetation that would cause such an effect, except, possibly, in small, steep, mountainous drainages, such as Siegel Creek, where the pipeline would closely parallel the stream. Flow alterations would also occur if a large amount of water were withdrawn from or discharged into a small stream during hydrostatic testing or when water is used to flush the pipe when it is abandoned.

Alteration of existing streamflow (whether an increase in peak flows or a decrease in minimum flows) can harm fish populations, particularly if the alteration occurs during critical times, such as migration, spawning, egg hatching, and fry rearing.

A section of a stream could be totally dewatered during construction of water crossings, causing mortality of benthic invertebrates and eggs in the dewatered section. Invertebrates would quickly recolonize the segment when flow resumed.

Acoustic Shock

Trenching for pipelines often requires blasting. The acoustic shock from instream blasting would have a short-term impact on fish. Impacts would not be limited only to instream blasting, because shock waves can travel through land to water. Besides killing fish, blasting can also disturb adult behavior during spawning.

Entrapment

During construction and hydrostatic testing pumps may be used to draw water out of many streams. Fish and other organisms sucked through such pumps during water intake would be killed.

TAPS Photo by Charles Kay

ACCESS ROAD WASHOUT AT A MISALIGNED AND UNDERSIZED CULVERT

Water Quality

Many aspects of pipeline construction can impair water quality. Oil spills and sedimentation have been discussed previously in this section. There would also be a risk that sanitary wastes and toxic material could, if not properly controlled, be introduced into water near construction sites or storage facilities if they were located near streams or other water bodies. Water quality also could be briefly impaired by discharged hydrotest water containing dust, rust, metal filings, and oily wastes from the inside of the pipe. NTPC has proposed adding a bactericide to the water for rust control, which would also lower water quality.

Organic Debris

Trees and branches that fall into the stream during right-of-way clearing can hinder fish passage and make streambeds unstable. Small debris (such as bark, wood fiber, and leaves) can have the same effects on benthic organisms as does fine-grained sedimentation.

Thermal Effects

The body temperature of fish and aquatic invertebrates approaches their external environment. Therefore, water temperature is an extremely important factor in the bodily functions and activities of these organisms. There could be some thermal impacts on organisms where pipeline right-of-way clearance would necessitate the removal of large amounts of vegetation cover from streambanks; increased exposure of the water to extreme cold during winter could cause loss by freezing over of wintering habitat. Increased solar radiation could heat water and increase photosynthetic activity. However, this requires more extensive removal of vegetation from streambanks than would be anticipated with the proposed pipeline, except possibly in Siegel and Prospect creeks where the pipeline closely parallels the water. If hydrotesting took place in the winter, the hydrotest water could be heated to prevent freezing. If not allowed to cool before being discharged into a stream, this water could raise stream temperatures. Currently, winter hydrotesting is not anticipated.

Increased Power Demands

Either coal or hydroelectric development would have adverse impacts on aquatic life and habitats. Energy demands for this project are discussed on p. 103.

MEPA Concerns

A significant impact to aquatic life and habitats is one that is measurable in terms of changes in populations, diversity, or productivity (Sharma et al. 1975). Long-term impacts are considered to be those which continue for several years.

Machinery oil and fuel spills during construction and crude-oil spills during operation are likely (see chapter five, p. 47). Generally, the adverse effects of smaller spills or leaks would be short term; a pipeline rupture would have more lasting impact than a minor spill. The degree of impact from a spill would depend on the size of spill, the type of waterway, and cleanup effectiveness. If an extensive fish kill were to occur, it would take years for the population to recover.

Impacts of sedimentation and suspended sediments may persist over the long term if bank restoration or right-of-way maintenance produces erosive conditions, but with proper mitigation sedimentation resulting from both activities would be short term. Even with the best mitigation, some short-term sedimentation impacts would result from pipeline construction.

Whether impacts of vegetation removal along streambanks were long or short term would depend on the type of vegetation affected and on what efforts were made to

TAPS Photo by Charles Kay

CULVERT BLOCKED BY GRAVEL GRADED OFF ROAD

restore cover and shade. Instream cover could also be lost at stream-crossing sites. Cumulatively, habitat loss from these sources could be large.

Long-term impact from drainage structures could be avoided by careful installation. Irretrievable loss of aquatic life and habitats would occur if rivers and streams were channelled.

The severity and duration of impacts on aquatic resources from the proposed pipeline would depend on the mitigating measures employed. Without proper use of such measures, long-term impacts would occur.

Mitigating Measures

Location of the Pipeline and Associated Facilities

The potential for damage to aquatic life and habitats would be reduced by:

1) Locating the pipeline route and related facilities in areas where the cumulative risk of damage to aquatic life and habitats would be the least.
2) Having an aquatic biologist and hydrologist make an on-the-ground inspection of the proposed centerline and, wherever practical, modifying the centerline and the location of associated facilities to avoid sites where there would be high risk of damaging aquatic life and habitats. General guidelines for centerline placement are included in **Northern Tier Report No. 3**.
3) Avoiding stream crossings and streambank encroachment, leaving buffer strips of undisturbed land at least 500 m (1,500 ft) wide along water bodies, except near crossing sites.

Construction-Related Oil Spills

Taking the following measures before construction would reduce damage caused by oil spills related to construction:

1) Formulating a plan concerning construction-related oil spills and having that plan reviewed and agreed upon by all participating parties.
2) Briefing all personnel thoroughly on reporting procedures and what would be expected from them in the event of a spill.
3) Having contractors use techniques that would minimize the possibility of oil spills reaching a water body, including proper methods of refueling and repairing equipment and correct methods of storing and disposing of all petroleum products.
4) Having sufficient equipment readily available and in good working order to clean up at least a 20-m³ (5,000-gallon) spill.

Mainline Oil Spills

The likelihood of and the damage caused by a mainline oil spill could be reduced by the following:

1) Having NTPC's Oil Spill Contingency Response Plan reviewed and approved in writing by the state before pipeline operation.
2) Designing and installing sensitive leak-detection units at all stream crossings to minimize the possibility of undetected leaks. (The line-volume detection system on TAPS was designed to detect a leak of 100 m³ (630 bpd).)
3) Locating block or check valves on both sides of streams and all other bodies of water considered by DFWP to be of significant value.
4) When feasible, using pipe-within-a-pipe construction at stream crossings so that spilled oil is led to catchment basins on the bank to decrease the probability of oil entering the stream.
5) Placing pipe at least 1.2 m (4 ft) below the maximum predicted depth of scour as established by field investigations and calculations that are agreed upon by both the company and those government agencies concerned (see chapter five).
6) Designing the pipeline to withstand the effects of the weather, hydrology, and hydraulics of each region through which the pipeline passes. (These effects would include runoff, stream and flood plain erosion, meander cutoffs, lateral migration, ice jams, and icings.)
7) Having the state review detailed plans for corrosion-resistant design and methods for early detection of corrosion.
8) Constructing impervious oil spill containment dikes or equivalent structures around storage tanks at pumping stations and at other pipeline facilities that have a volume of at least 110 percent of the total storage volume of the storage tanks in the area.
9) Constructing oil-spill containment dikes to withstand failure from earthquakes, and rip-rapping them on the outside in flood plains for protection from flood waters.
10) Locating pump stations as far away from waterways as possible.

Stream and River Crossings

The many possible impacts to aquatic life and habitats associated with stream and river crossings could be reduced by using the following measures:

1) Having the crossing site inspected and the construction plans approved before beginning construction.
2) Constructing trenched stream crossings during periods least critical to fisheries or during periods of low flow when sediment transport would be the least. (Table 31 gives critical periods for species that could be affected by the pipeline in Montana).
3) Constructing all trenched river crossings in the shortest time possible, working 24 hours a day from the time the crossing is started to reduce the time during which silt can be washed into the river.
4) Drilling under or constructing aerial crossings over biologically unique or sensitive streams.
5) Ensuring that support structures for aerial crossings are located away from or adequately protected from the effects of scour, channel migration, undercutting, ice forces, and other external and internal loads.
6) Pumping the silty water to a settling pond before returning it to the river when it is necessary to dewater excavated footing sites for suspension towers, pits, or the pipeline trench.
7) Covering pump intakes with screen boxes to protect fish.
8) Using techniques such as hard plugs, soft plugs, or silt curtains and other construction methods to reduce the amount of sediment entering streams and the distance it is transported.
9) Fluming or pumping the flow of smaller streams around the crossing site during construction.
10) Allowing no temporary instream storage of ditch spoil.
11) Removing excess ditch spoil to areas where it cannot reenter the stream.
12) Clearing extra working widths at river crossings for the temporary storage of excavated ditch spoil so that at least a 15-m (50-ft) buffer strip of natural vegetation is between the storage sites and the river. (This may be necessary only on one bank.)
13) Pumping ditch spoil excavated with a suction dredge through a temporary floating pipeline to an impervious diked sited where the spoil will not reenter the stream.
14) Backfilling the crossing with granular material containing little silt if the excavated ditch material is not suitable for backfill.
15) Using backfilling materials that cause no significant aggregation or degradation instream.
16) Restoring stream channels and banks to their original configurations, and stabilizing the banks with trees, grass, and shrubs.
17) Using rip-rap or gabions to stabilize the banks only as a supplement to natural vegetation or where such methods can be used to improve existing fish habitat.
18) Burying the pipeline deep enough at crossings so that tree roots would not be a hazard.
19) Using tree stumps removed from the right-of-way to stabilize the streambank and provide fish cover.
20) Using fill ramps for temporary access over streambanks rather than cutting ramps through streambanks, removing the ramps, and reestablishing the threads of the streams, after the crossings are complete.
21) Preventing solid matter, debris, and contaminants from spilling into waterways, lakes, and underground waterways.

22) Using equipment in waterways as little as possible, and steam cleaning the equipment before it enters the water.
23) Reducing peak pressures of instream and streambank blasting by using the smallest amount of explosives needed and, when more than one charge is used, wiring them in series with at least a 17-millisecond detonation delay between each. (On TAPS, a powder factor of one pound or less per cubic yard was used when the pipeline company had to blast near any fish stream).
24) At crossing sites where a river's flow is naturally divided into two stable channels, diverting the entire flow through one channel while constructing the crossing of the other.

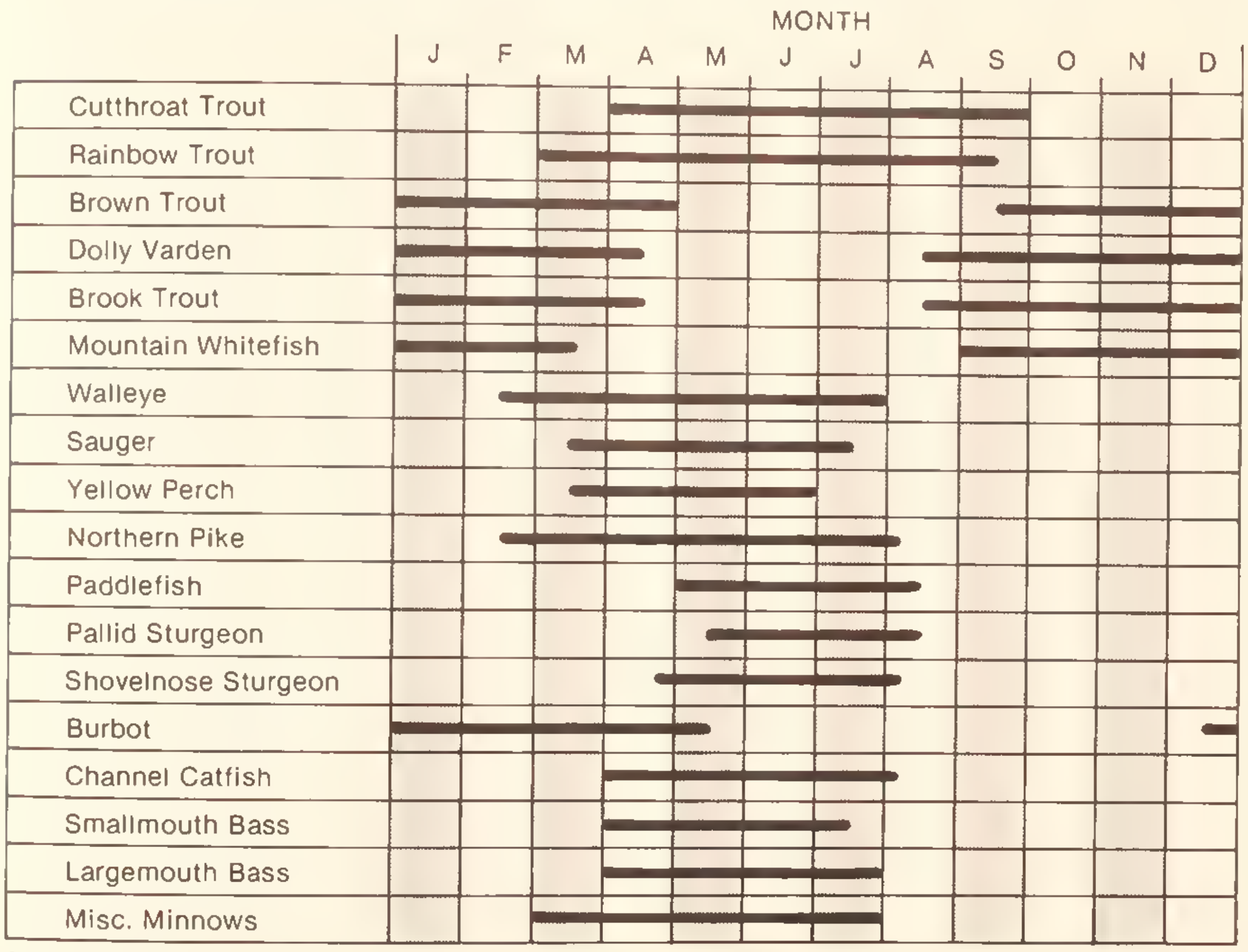
5) Prohibiting the use of pesticides and herbicides near streams.
6) Building sediment retention basins where they can catch sediment from the right-of-way or access roads before it endangers the quality of nearby waterways.

Drainage Structures

Damage to the aquatic environment could be reduced by the following measures:

1) Using the drainage structure most suitable for each site's soil conditions and stream morphology.
2) Installing the proper sized drainage structures to ensure fish passage and avoid ponding and washouts.

TABLE 31. CRITICAL TIME PERIODS FOR KEY MONTANA FISH SPECIES THAT POSSIBLY WOULD BE AFFECTED BY THE NORTHERN TIER PIPELINE (includes migrations, spawning, and development to fry stage)



Source Brown 1971
Scott and Crossman 1973

Construction Right-of-way

Adverse impacts to aquatic life and habitats could be reduced by taking the following measures:

1) Using the erosion control and prevention discussed in the **Northern Tier Report Nos. 1 and 3** for access roads and the cleared right-of-way.
2) Hand clearing the right-of-way within 30 to 45 m (100 to 150 ft) of all waterways.
3) Felling all trees, snags, and other wood material away from waterways.
4) Immediately removing any debris that may accidentally fall in waterways during right-of-way clearing.
3) Installing drainage structures that alter the natural hydrogeologic balance of streams as little as possible.
4) Constructing drainage structures with only one traffice lane (5 to 6 m or 15 to 20 ft) wide so that the stream is disturbed as little as possible.
5) Constructing all crossings at right angles to the streambed when feasible.
6) Designing and constructing the slopes of cuts through streambanks to reduce erosion as much as possible and prevent slides.
7) Using bridges for crossing all fish streams that completely span the natural streambed with no instream pilings and which have approaches that do not restrict the normal flood plain. Bailey bridges can be easily disassembled, moved to new streams, and used repeatedly at numerous crossings.
8) Removing temporary bridges without damaging streambanks or streambeds.
9) Using culverts on fish streams as an alternative to bridges only where there is 0.5 percent or less gradient, near-constant flow, little or no bedload transport, and low susceptibility to icing or plugging with debris.
10) Placing energy dissipation structures at the outlets of culverts used on high-gradient ephemeral drainages.
11) Armoring culvert inlets and outlets with appropriate material to prevent erosion.
12) Constructing settling basins at the lower end of culverts where necessary because of outlet erosion.
13) Placing the bottoms of culverts 0.15 m (0.5 ft) below the natural streambed at the outlet.
14) Placing proper bedding, padding, and coverings around culverts to prevent them from being crushed by heavy equipment.
15) Using by-pass pumps to dry the streambed while culverts and fords are being installed.
16) Using temporary bridges or culverts (but not fords) during the construction phases of the project. Temporary culverts could be safely replaced with fords built to specification after construction if only occasional traffic is anticipated during operation and maintenance.
17) Using fords only as drainage structures on ephemeral drainages or streams without fish.
18) Avoiding installation of fords at deeply incised streams or in unstable soils where banks would require excessive excavation.
19) Constructing fords to match the existing stream geometry as closely as possible.
20) Selectively choosing, sorting, and mixing the fill material used in the construction of fords so it is in the proper proportions to support traffic, prevent rutting, reduce siltation, prevent washouts, preclude French drains, and allow fish to pass freely. (Deep layers of small angular and subangular rock, chinked with finer particles for a binder, provides one of the best surfacings to meet these criteria.)

Material Sites

Damage to aquatic systems can be reduced by:

1) Preparing a detailed plan for material sites.
2) Constructing levees, berms or other suitable means to protect fish and fish passage, and to prevent siltation if material sites which are approved are adjacent to or in lakes, rivers, streams or wetlands.

Hydrostatic Testing

Damage to aquatic systems can be reduced during hydrostatic testing by:

1) Withdrawing no more than one-eighth to one-fourth of the streamflow during hydrotesting.
2) Excavating only where the streambed or streambanks have already been disturbed (as in a trenched crossing), if a bank must be cut down or a sump enlarged for a pump.
3) Placing each pump intake within its own 0.28-m-square (3-ft-square) screen box to prevent fish from being sucked into the pumps and to prevent pump suction from holding small fish against the screened side, which could happen if a smaller pump intake box were used.
4) Attaching an energy dissipation system to the end of each discharge line and staking a board flat on the ground beneath the end of the dissipator so that the water flows over the board before it reaches the ground.
5) Avoiding discharging water onto steep slopes. If the water must be emptied onto a steep slope, impact would be reduced by choosing a location which would not funnel the water into a natural drainage below the energy dissipation system.
6) Not emptying the test water (which has high levels of grease, oils, and suspended sediments) directly into any waterway. Water could be discharged into a holding pond, tested for impurities, held until sediments have settled, and then returned clean to water courses.
7) Regulating the use of methanol or antifreeze in hydrotest water. (If it is necessary to hydrotest the pipeline in below-freezing weather, heated water could be used if allowed to cool before it is discharged into streams.)

Construction Monitoring

Damage to aquatic systems resulting from pipeline construction could be reduced if a biologist and hydrologist monitored construction to ensure consideration of aquatic life and habitats. This could also enable studies to further assess the relative impacts associated with construction techniques and mitigating measures.

Compensation

Damage to aquatic systems resulting from construction or operation of a pipeline could be partially mitigated by paying the value of fish lost. The value of fish cannot be predetermined because it is increasing at a highly accelerated rate; thus, the value should be negotiated following a fish kill.

GROUND WATER

Ground water in Montana varies in quality and abundance, reflecting significant differences in topography, climate, and geology. Along all proposed routes, it is the primary source of domestic and stock water, and is widely used for irrigation and municipal purposes. Ground water was assessed along the proposed routes, and the potential impacts of the proposed action were evaluated. Areas of potentially high risk to ground water are shown on map 4, p. 48.

Western Montana has many large mountain ranges composed primarily of sedimentary rock of Precambrian age. These rocks characteristically have low permeabilities and generally contain small amounts of good-quality ground water. Many of the larger valleys in western Montana contain deep fills of Tertiary sediments which are exposed principally as high terraces in large valleys. Ground water yield in these sediments range from small to moderate and are usually found at depths below 30 m (100 ft). Unconsolidated alluvial deposits are present along most major western Montana streams. These deposits—composed of layers and mixtures of sand, gravel, silt, and clay—often contain large quantities of good-quality ground water. Along Ninemile Creek and in the Missoula and Jocko valleys, fine-grained, glacial-lake sediments overlie older, coarse-grained stream deposits. Ground water in these areas is often under artesian pressures. Good-quality ground water is also found in glacial till and glacial outwash; these deposits are common in western Montana and often have high yields of water.

Central Montana contains a variety of geological formations, with bedrock ranging in age from Precambrian to Tertiary. The bedrock aquifers (water-bearing zones) are primarily permeable sandstones and limestones containing good-quality ground water. Many large intermountain valleys are flanked by semiconsolidated Tertiary sediments which generally contain small amounts of fair-quality ground water. Along major streams and their tributaries is unconsolidated sediment of Pleistocene to Recent age consisting of gravel, sand, silt, and clay. These deposits commonly yield moderate to large quantities of good to poor quality water from shallow depths. The abundance of ground water decreases and quality becomes poorer towards the eastern and northern sections of central Montana.

The eastern Montana ground-water region includes the plains, rolling hills, and breaks that extend from the mountains and uplifts of central Montana eastward to North Dakota. This area has relatively flat-lying sedimentary rocks, commonly of Tertiary to Cretaceous age. North of the Missouri River the area generally is covered with thin glacial deposits. Bedrock formations are a major source of ground water, normally yielding small to occasionally moderate quantities of fair to poor quality ground water. Glacial till and glacial outwash material cover nearly all of eastern Montana north of the Missouri River. These deposits usually produce small amounts of ground water of fair to poor quality. South of the Missouri River, the bedrock formations normally are not covered by glacial till. In eastern Montana unconsolidated sediments along major streams and their tributaries are an important and widely used source of ground water, which is usually of fair to poor quality, with small to occasionally moderate yields. Ground water yields in eastern Montana are generally smaller than in central or western Montana, and water quality is poorer. Because eastern Montana has limited surface-water resources, ground water is of vital importance to this region.

Impacts

Impacts to ground water in shallow aquifers can occur during construction, operation, and abandonment of the proposed pipeline. However, there would be little probability of deep aquifers being adversely impacted by the pipeline construction or by oil spills. See table 32 for a summary of potential impacts on ground water.

Construction

Excavation necessary for burial of the pipe may intercept shallow ground water, and removal of this water may disrupt shallow systems; however, these impacts would probably be negligible. During hydrostatic testing of the pipeline, surface water would be used. Several contaminants could get into the test water; these include oil and grease, rust, dirt, and metal fragments from welding. Also, the test water may be treated with chemicals such as soda ash, and bactericides to prevent corrosion during testing (NTPC 1979d). A leak in the pipeline during testing or disposal of test water could introduce contaminants into shallow aquifers and cause localized minor degradation of ground-water quality.

Operation

Crude oil is a complex mixture of hydrocarbons, trace metals, and compounds containing sulfur, oxygen, and nitrogen, and is a viscous fluid in comparison to water. Although relatively insoluble in water if compared to substances such as salt or sugar, hydrocarbon components vary considerably in solubility. A sufficient amount can dissolve in water and would cause severe odor and taste problems. The odor detection limit of raw petroleum is 0.1 to 0.5 mg/l (McKee and Wolf 1963); thus, a small quantity of dissolved oil can contaminate a large volume of water. Hazards to human health from consuming oil-polluted water, are not great because the water would have an objectionable taste and odor at concentrations well below the chronic-toxicity level (McKee and Wolf 1963). However, stock animals might unknowningly drink seriously contaminated water, there is no information available which would allow quantitative estimates of the likelihood of this.

A leak or rupture of the pipe would be the greatest potential impact on ground water, particularly if an oil spill reaches an aquifer used for domestic purposes, irrigation, or livestock.

Oil pollution is essentially a shallow ground water problem (Osgood 1974). It has been estimated that leaks of less than 20 L (5

gallons) per minute may be completely retained in soil and might not reach the ground surface (USDI 1977). Spills from a complete rupture of the line would undoubtedly surface, since the volume of spilled oil would greatly exceed the absorbency of the soil. Subsurface oil flow may continue after surface flow has stopped, and eventually may affect a larger area than the surface flow.

The rate and depth of oil penetration from surface flow would depend on many interrelated factors, including the viscosity and pour point of the oil, the permeability of the vegetation and soil, the cohesive forces between oil and soil or vegetation, and the depth of the ground-water table or other aquifers. The soil would absorb and immobilize oil in direct proportion to its porosity (a measure of the open pore space in soil or rock). If the porosity of the soil and the volume and lateral extent of the spill are known, the depth of oil penetration can be calculated. Oil usually will move downward through the soil in the shape of a cone, as shown in figure 18. The degree of lateral movement in soil would depend on soil permeability and homogeneity. Vertical and horizontal movement through a rock formation would depend on the degree of fracturing of the rock, highly fractured rocks permitting oil to move more freely than nonfractured rock.

Although oil may be temporarily immobilized within soil or rock, it would not necessarily remain there. Rain water percolating through the formation would remobilize some of the oil by dissolving some components of crude and also by actual displacement of the oil through the pores in the soil or rock.

If the undissolved oil contacts the water table, it would spread out on top of the existing ground water and form a lens. Most oil would float on the water table, where it initially would flow outward in a radial pattern from the spill site. After radial spreading, the oil would flow in the same direction as the ground water flow. The oil lens could encounter barriers to movement, such as formations through which the water would flow but which would slow down oil because of its higher viscosity. Eventually the oil would either be immobilized by the soil or would appear at sites of ground water discharge.

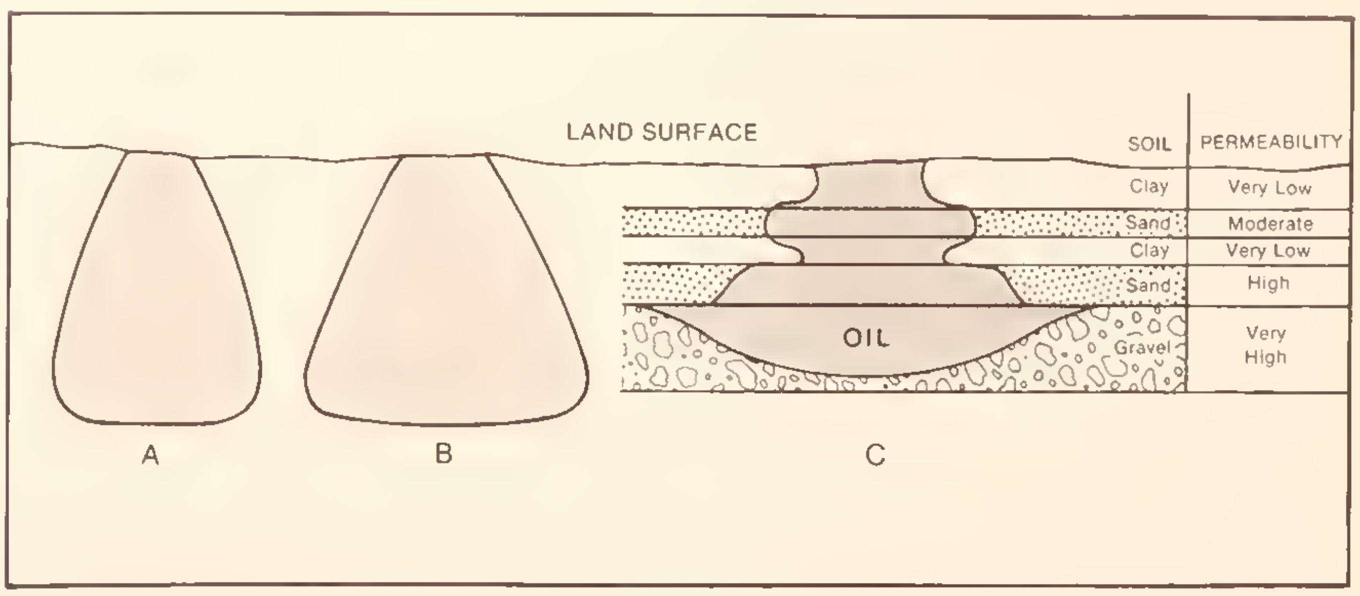
Alaskan crude oil is about thirty times more viscous than water at 15 degrees C (60 degrees F) and would move through an aquifer about thirty times slower than water. Other oils, such as Indonesian and Mid-Eastern oils, may be less viscous and thus move faster. The velocity of ground water ranges from a few feet per day to a few feet per year (Todd 1969). In the Helena Valley, for example, a typical velocity of ground water movement in the shallow alluvial aquifer is estimated to range from 60 to 300 cm (2 to 10 ft) per day. Alaskan crude oil movement in this same aquifer probably would be from 2 to 9 cm (0.07 to 0.3 ft) per day. This means crude oil movement would be much slower than the normal ground water movement and contamination from oil would spread slowly. Fractions of crude oil dissolved in an aquifer would move faster than the floating lens. These dissolved components would generally move at the same rate as the water, although interactions with porous medium may impede flow.

TABLE 32. SUMMARY OF POTENTIAL IMPACTS ON GROUND WATER

PHASE	DESCRIPTION OF IMPACT	LIKELIHOOD[1]	PROBABLE SIGNIFICANCE[1]
Construction and Abandonment	Excavations during trenching intercept shallow ground-water systems	Probable at several locales	Negligible, if impact occurs
	Ground water contaminated by leakage or disposal of contaminated wastes such as diesel fuel during construction, flushing, or hydrostatic testing of the pipeline	Probable at several test sites	Minor if tests and construction carefully controlled
Operation	Ground water affected by small leak in pipe; detected soon, or in area not susceptible to downward movement of oil	Probable at many locales	Minor
	Ground water affected by small, slow leaks in pipe; not detected for weeks or months	Probable at one or several locales	Long-term minor to major impact, depending on specific aquifer affected
	Ground water affected by major leak in pipe	Probable at one or several locales	Minor to moderate (Leak would generally be quickly detected and cleaned up before major problems develop)
	Oil in ground-water aquifer reaches wells used for human water supply, causing odor and taste problems.	Unlikely except in high density population areas with shallow aquifers possibly one or two instances	Long-term minor to major problem, depending on specific aquifer affected
	Ground water contaminated by oil from leaky storage tanks, or other facilities	Unlikely if site-studies and spill-control measures are properly done	Negligible

[1] Best judgment of DNRC staff. Available evidence is inadequate for quantitative predictions.

FIGURE 18. GENERALIZED SHAPES OF SPREADING CONES AT IMMOBILE SATURATION



A - HIGHLY PERMEABLE, HOMOGENEOUS SOIL
B - LESS PERMEABLE, HOMOGENEOUS SOIL
C - LAYERED SOILS WITH DIFFERING PERMEABILITIES

Source: American Petroleum Institute 1972

Small, undetectable leaks are the most common pipeline failures and would probably be the most likely to cause problems with ground water quality. Such leaks could go undetected for a long time and could contaminate a large volume of ground water before a problem was suspected. Slow leaks under a ground cover of ice or possibly crusty snow might go undetected for along time and ground-water contamination could occur if the soil near the leak was not frozen.

Abandonment

Removal of residual oil within the pipeline would be done by flushing the pipe with water which would be placed in holding ponds to separate the oil from the water. If reasonable precautions were used, abandonment should have negligible impacts on ground water.

MEPA Concerns

A summary of the probable impacts to ground water is included in table 32. Many potential impacts to ground water, such as disruption of flow during construction of the proposed pipeline, would probably be short term and could be eliminated or abated within a matter of months to two years. Some potential spills would be completely immobilized in the soil and the soil could subsequently be reclaimed (see "Soils," p. 65). Other short-term impacts would occur if a small volume of oil reached the water table but the oil were successfully removed, or if the volume of dissolved oil were not large enough to cause ground-water pollution problems.

There would be long-term impacts if mitigating measures to protect ground water were ineffective in cleaning up a spill after it reached the water table. Generally, recovery of oil in an aquifer is expensive, technically difficult, and takes a long time (Osgood 1974). For example, a spill in highly fractured bedrock would be difficult to recover since rock is not easily removed and pumping may not be possible. In some cases, it may not be economically feasible. If a significant volume of oil does reach the water table, a portion would dissolve in the groundwater. The dissolved fraction would remain and cause odor and taste problems for a long time, even if much of the oil were recovered.

Neither construction nor abandonment of the pipeline would be anticipated to cause any irreversible effects on ground water. Excavations for burial and/or removal of the pipe would probably have negligible effects on subsurface waters. However, seepage of a substantial volume of oil into an important ground-water aquifer would have an enduring effect. This could lead to the pollution of wells, springs, or surface water bodies supplied by the ground water system.

There are a number of factors that would limit the size and severity of a ground-water pollution problem; these include immobilization of oil in earth materials, biological decomposition of the oil, and discharge of the oil to surface waters. Previous spills (see table 26, p. 47) of petroleum products and crude oil in Montana have created ground water pollution problems, some of which have persisted for a number of years. These problems eventually correct themselves after tens to hundreds of years.

Mitigating Measures

Oil Spills

In the event of an oil spill, the following measures would reduce adverse impacts to ground water:

1) Including in NTPC's "Oil Spill Contingency Response Plan":

   a) Site-specific procedures and equipment that could be used in the event of ground-water contamination. Geologic and hydrologic information about critical and sensitive aquifers could be gathered while formulating the plan, rather than attempting to get this information after a spill has occurred. This is particularly important in populated areas where ground water is used for human consumption.

   b) Provision for ensuring rapid response time to control the spread of spills wherever sensitive or critical ground water is at risk. Contaminated water is far more difficult to clean up than is contaminated soil near the ground surface.

   c) A list of state agencies and organizations to be notified, as well as a cleanup plan requiring the use of pollution-control equipment and trained pollution-control specialists.

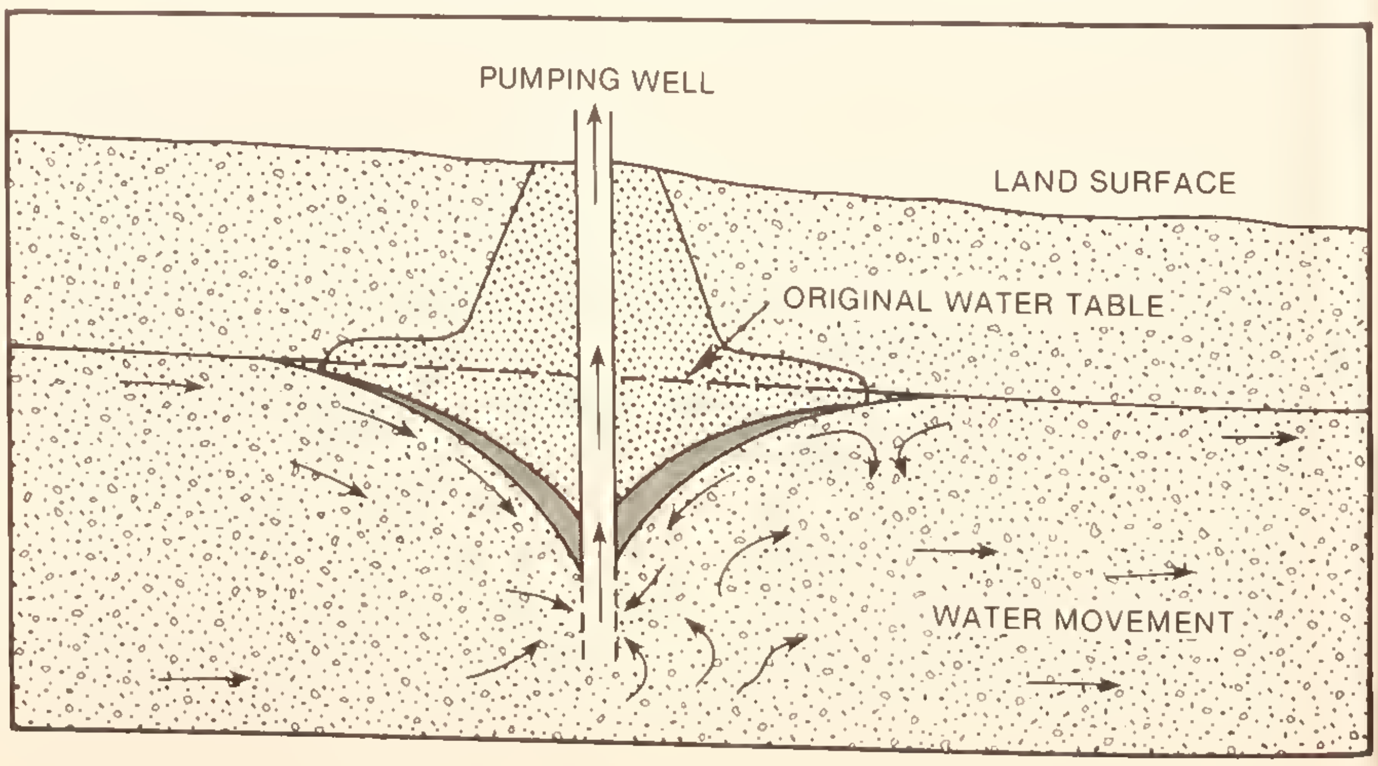
2) Using trench backfill that would force leaking oil to flow upwards. This could be done where important aquifers were at risk from oil spills by backfilling the bottom and sides of the pipe trench with relatively impermeable material, and backfilling over the trench with permeable material. Leaking oil would move upward and appear at the ground surface, allowing early detecton.
3) Placing a filter in contaminated domestic or public water supply systems to temporarily remove health hazards until contamination is eliminated or abated.
4) Using water flooding, interception barriers, and pumping wells to reduce ground water contamination (see figures 19 and 20).
5) Increasing pipe wall thickness in areas of shallow, high-quality aquifers to reduce the risk of oil spills in these areas.

VEGETATION AND LAND PRODUCTIVITY

NTPC's proposed system would cross a diversity of vegetation in Montana that reflects the state's climatic variations. Ample precipitation in western Montana supports coniferous forests, while the vegetation in the drier eastern part of the state is dominated by grasslands. Deciduous forests of primarily cottonwood follow the state's major streams and rivers, and green ash and box elder can be found along coulees and draws.

The existing vegetation (or land cover) of the study corridors was categorized and mapped according to the categories listed in table 33, p. 82. Areas of highest risk of impact to vegetation are shown on map 7, p. 80. For further discussion of impacts, see **Northern Tier Report No. 1**.

FIGURE 19. OIL ON WATER TABLE IS TRAPPED IN CONE OF DEPRESSION CREATED BY DOWNDRAW OF PUMPING WELL



Source American Petroleum Institute 1972

Impacts

Effects of Pipeline Construction

Loss of Vegetation from Right-of-Way Clearing. Complete removal of all land cover within the construction right-of-way would result in a major impact to vegetation. NTPC's 27-m (90-ft) construction right-of-way for its proposed route would require clearing an estimated 568 ha (1,403 acres) of forest land, 1,608 ha (3,973 acres) of grassland, 517 ha (1,278 acres) of agricultural land, and 6 ha (16 acres) of bottomland and wetlands. Losses of scarce or limited vegetation, such as riparian or wetlands areas, or damage to threatened or endangered species and their habitat would be an especially important impact. Table 34, p. 82, lists threatened and endangered plants in Montana which can be found within the study corridors. Construction-related soil compaction and soil horizon mixing (see "Soils," p. 65) can affect reclamation success and the nature of vegetation eventually reestablished on the right-of-way.

Hyrdostatic Testing. Water would be discharged at specific locations during depressurizing of the pipeline test sections at volumes as high as 8.6 million gallons for a 32-km (20-mi) test section. In addition, water may leak from faulty welds or ruptures. Expulsion of pressurized water could result in soil erosion and plant damage. The quality of discharge water, which often contains potentially phytotoxic residues, could also affect vegetation. Water discharged from TAPS pump stations has contained levels as high as 56.9 ppm oil and grease, and 24,820 ppm suspended solids. If similar discharge water quality resulted from NTPC's hydrostatic testing, losses to vegetation could be comparable to those from minor oil spills.

Sediment and Erosion Impacts. Construction activities involved in clearing streambank vegetation, stream trenching, and pipeline placement would cause increases in stream sediment load. Unstable sediments rapidly shift with variations in stream velocity, sometimes burying plants or causing wash-out areas which do not allow reestablishment of plants. Construction would also result in dust deposits on vegetation on each side of roads and the construction right-of-way. This may affect plant growth by reducing transpiration and photosynthesis.

The extent of soil loss from wind and water erosion during pipeline construction and maintenance would depend on reclamation practices and the rate of reestablishment of a permanent, stable land over. Some erosion would likely occur regardless of which reclamation methods were used. Erosion affects vegetation by exposing root structures and causing plant dehydration. Some plants may be buried by sediment transported by wind or water. Seed produced by native vegetation or seeded as part of the reclamation procedure may also be carried away by erosion (see **Northern Tier Report No. 1**).

Effects of Pipeline Operation and Maintenance

Right-of-Way Maintenance. NTPC's proposed 23-m (75-ft) permanent right-of-way would be kept free of all trees and tall-growing shrubs for the life of the project, primarily to facilitate aerial surveillance and provide access for maintenance equipment. Vegetation need not be cleared from the entire permanent easement to prevent encroachment by residential and commercial developments. There would be a long-term loss in productivity of forested areas resulting from these maintenance practices. In addition, time would be needed to return these areas to their previous plant community structure. Right-of-way across grasslands would be reclaimed shortly after the completion of pipeline construction.

Off-Road Vehicles. Off-road vehicles would have access to the pipeline route during operation and maintenance of the line. Frequent or indiscriminate use would cause vegetation damage and impede reclamation attempts. A loss in vegetative cover from ruts and trails would cause soil compaction, increase soil erosion and dust pollution, and alter natural drainage patterns.

Thermal Effects. Oil temperatures within the pipe would probably be near ground temperature for most of the pipeline route through Montana (USDI 1979). Where oil flows are increased near pump stations, however, oil temperature would be at least 21 degrees C (70 degrees F). Since most Montana plants have phenological responses relating to critical temperature or light conditions, raising the soil temperature could cause premature seasonal growth. This early growth could attract grazing animals and cause over grazing.

Fire Hazard. Construction-related removal of forest land would require proper slash disposal to prevent a buildup of combustible materials. If a fuel buildup occurred—along with the use of heavy equipment, diesel-fuel spills, and the influx of large numbers of construction workers—the probability of a fire along the route would increase.

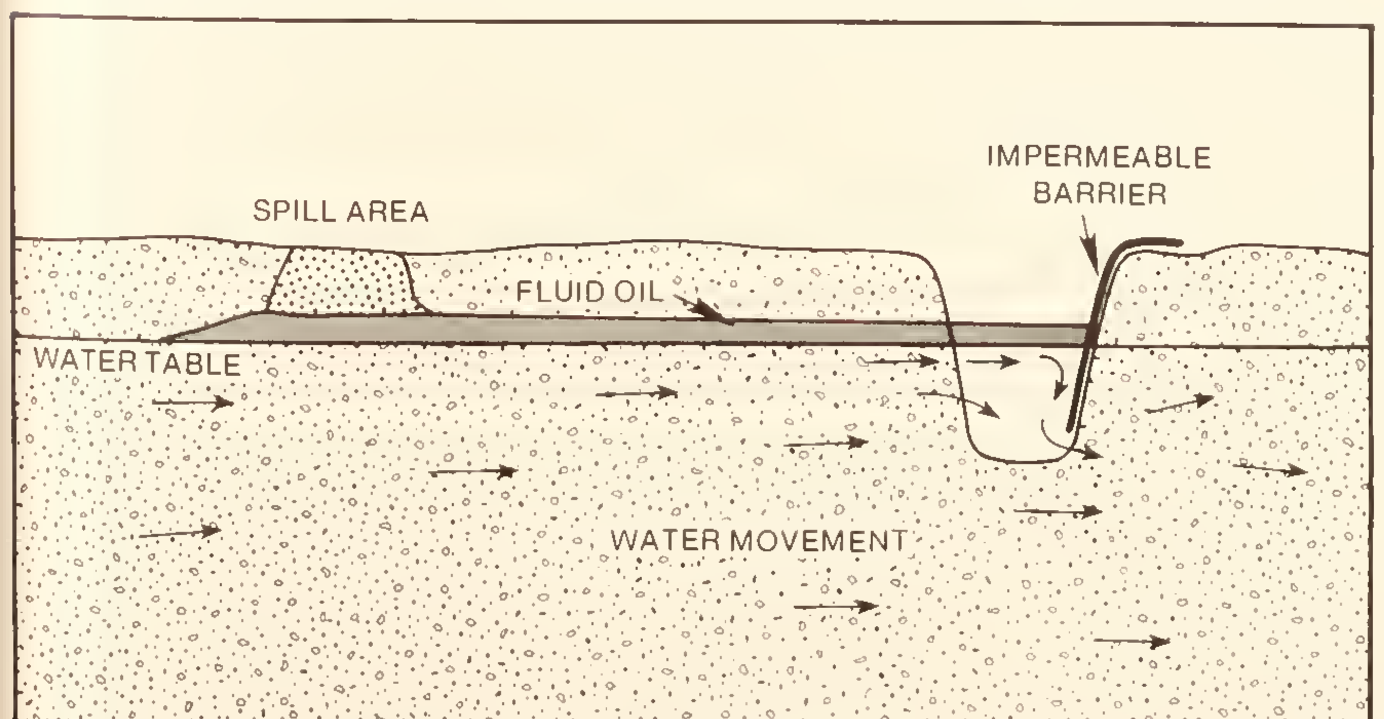
Weeds. Weed infestations can be a problem on pipeline rights-of-way. Depending upon the season in which construction would be done, the length of the construction period, the amount of time between the end of construction and the start of revegetation, and the nature of nearby weed stands, many species of weeds could become established. Most would likely be annuals or biennials (such as pigweeds or mullein), but perennials (such as Canadian thistle) may spread to the right-of-way by way of rhizomes or fragmented roots and eventually become established. Perennial noxious weeds could be a problem if allowed to become established in or adjacent to cropland.

Herbicides. Rights-of-way for powerlines, highways, railroads, and pipelines often are sprayed as part of the maintenance programs, and to control weeds in agricultural areas. However, NTPC proposes to use no herbicides for right-of-way clearing or maintenance; herbicides would be used only in the vicinity of pump stations and delivery facilities where all vegetation must be suppressed (NTPC 1979e).

Effects of Associated Facilities

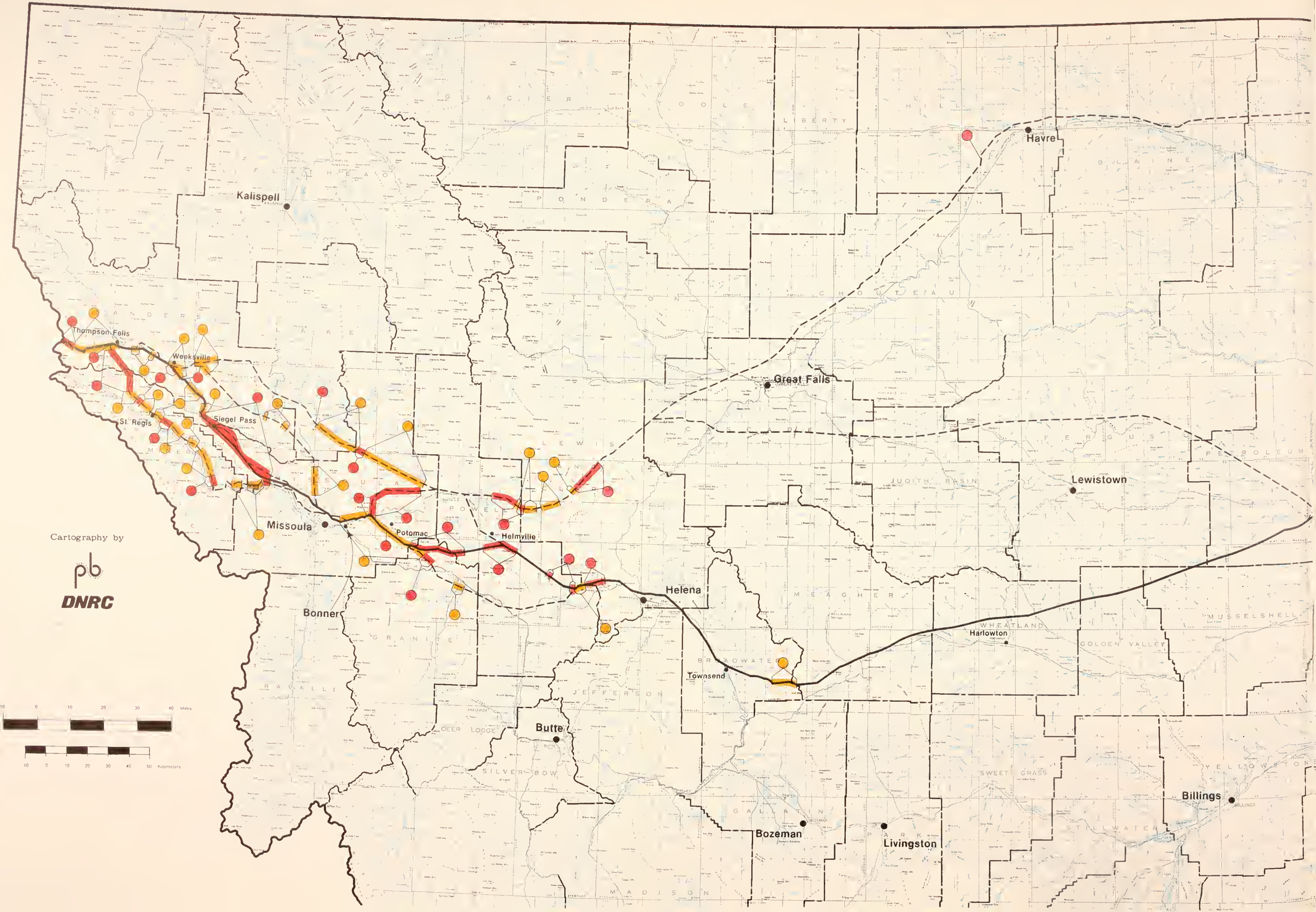
NTPC's associated facilities would greatly affect vegetation. For instance, on NTPR's proposed route approximately 59 ha (145 acres) of vegetation in Montana would suffer a long-term loss from the location of seven pump stations and two delivery

FIGURE 20. OIL MOVEMENT WITH SHALLOW GROUND WATER INTERCEPTED BY DITCH CONSTRUCTED ACROSS MIGRATION PATH



Source: American Petroleum Institute 1972

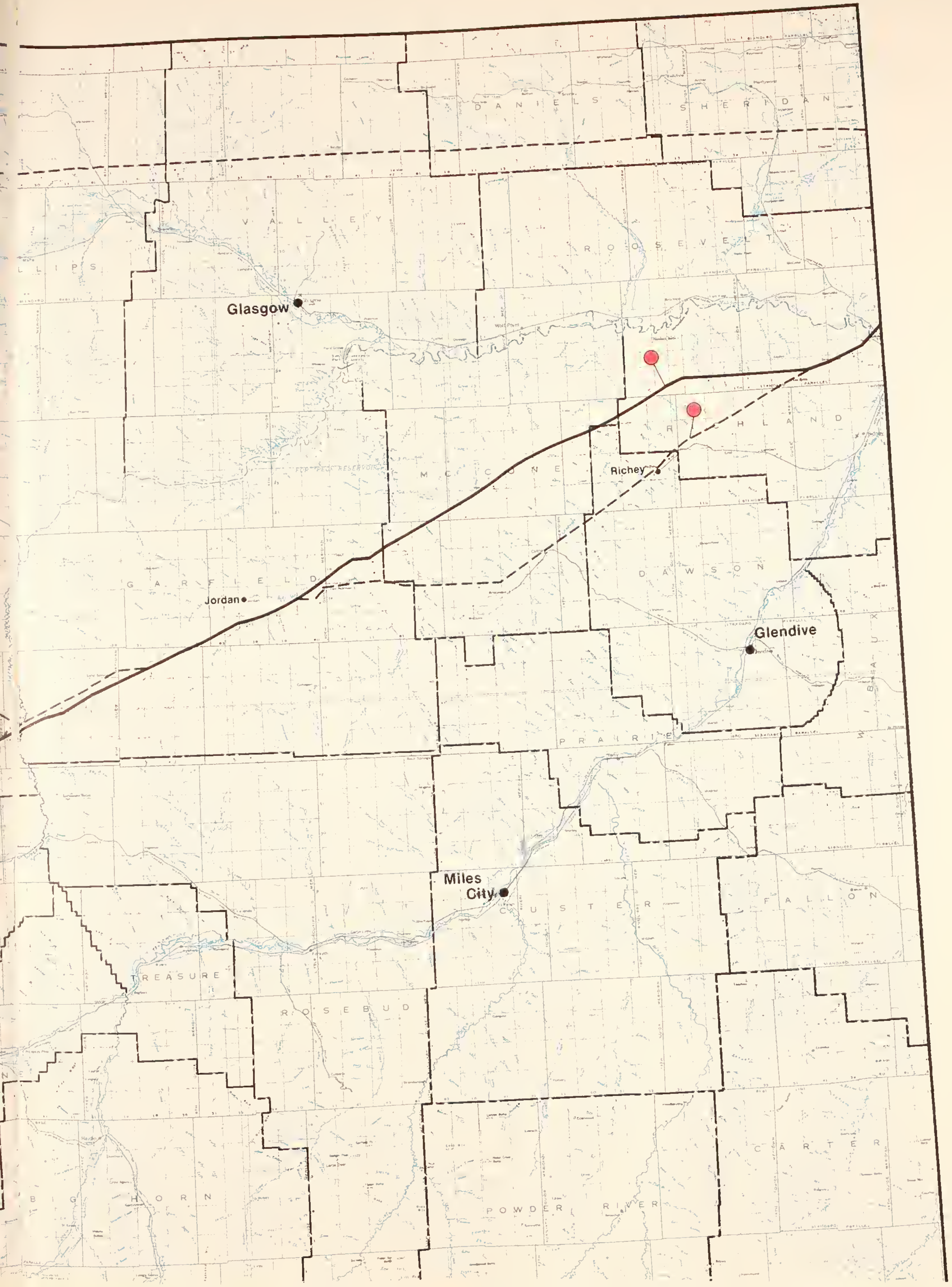
MAP NO. SEVEN



Thompson Falls
Weeksville
St. Regis
Siegel Pass
Kalispell
Missoula
Potomac
Helmville
Bonner
Havre
Great Falls
Lewistown
Helena
Townsend
Harlowton
Butte
Bozeman
Livingston
Billings
Cartography by
DNRC
Miles
Kilometers

MAP NO. SEVEN

VEGETATION AND LAND PRODUCTIVITY



Critical Areas

Sensitive Areas

VEGETATION AND LAND PRODUCTIVITY

facilities. Short-term impact would result from a two-to-sixteen month use of 280 ha (700 acres) at fourteen material stockpile sites along the route. If roads are built to provide access along the pipeline during its operation, they would destroy a considerable amount of vegetation, and lack of plant cover would cause increased erosion.

Effects of Oil Spills

Oil spills would have an immediate devastating effect on vegetation within the spill area. Oil may kill the plant directly through its herbicidal action on aerial portions of the plant or by envelopment of lower plant species such as mosses and lichens. Larger plants not killed outright often die from premature loss of foliage and subsequent seasonal stress. Vegetation surviving an oil spill often has reduced growth.

Oil contamination of the soil has a number of adverse effects on vegetation. Seed germination is affected by oil soaking through the seed coat and destroying the embryo. Germination appears to be adversely affected in mineral soils when oil content reaches 2 to 4 percent oil content by weight. Crude oil in the soil can form a surface crust and reduce soil aeration, impair surface gas exchange, reduce water-holding characteristics, cause intense microbial action leading to nitrogen deficiencies in the soil, and produce toxic materials. All of these effects may lead to vegetation reduction.

The significance of impact of an oil spill depends on the amount spilled, the time of the year, soil characteristics, topography, vegetation, and oil viscosity. Topography is a major influence, with land depressions constricting the oil and flat land allowing a more widely dispersed flow. In rolling terrain, the area of contamination is not proportional to spill volume; rather, the depth at the center of the spill becomes greater and the rate of spread at the periphery becomes smaller with increased oil loss (see **Northern Tier Report No. 1**).

Agricultural productivity is greatly reduced for up to five years in soils with 2.5 percent oil by weight if no reclamation measures are taken. Areas have been reported in Canada to be without vegetation three years after a light-to-moderate oil spill. All oil spills would cause losses in vegetation and soil productivity for at least two to five years, depending on the topography, environmental condition, and reclamation practices employed.

Effects of Pipeline Abandonment

In general, the effects of pipeline abandonment would be similar to those of construction. Impacts of pipeline flushing and wastewater treatment would be much the same as those of hydrostatic testing, although considerable crude oil would be present in the wastewater. Recovery of the abandoned pipe would require right-of-way clearing, trenching and backfill; however, much more flexibility in timing of construction activities may be possible. A second

TABLE 33. SUMMARY OF PRODUCTIVITY AND RECOVERY RATINGS FOR VARIOUS VEGETATION TYPES[1]

VEGETATION TYPE	DOMINANT SPECIES OF ECONOMIC IMPORTANCE	TIMBER PRODUCTIVITY RATING	LIVESTOCK FORAGE PRODUCTIVITY RATING	CROPLAND PRODUCTIVITY RATING	RECOVERY RATING
Irrigated Cropland	—	—	—	10	1
Wetlands	Cordgrass, Sedges	—	10	—	1
Dry Cropland	—	—	—	9	2
Sagebrush-Grassland	Blue Grama Needlegrasses Wheatgrasses	—	9	—	2
Riparian Cottonwood	Cottonwood, Snowberry Rose, Bluegrasses Hawthorne	—	9	—	3
Deciduous Coulees	Silver Buffaloberry Bluegrasses Wheatgrasses	—	7	—	3
Cedar-Hemlock Series	Western Red Cedar Western Hemlock Western Larch Western White Pine Douglas Fir	9	1	—	4
Grand Fir Series	Grand Fir Douglas Fir Western Larch Ponderosa Pine Western White Pine	7	3	—	4
Spruce Series	Spruce, Douglas Fir Western Larch Lodgepole Pine	6	3	—	5
Subalpine Fir Series	Subalpine Fir Lodgepole Pine Douglas Fir Western Larch	5	2	—	5
Douglas Fir Series	Douglas Fir Ponderosa Pine Western Larch Lodgepole Pine Rough & Idaho Fescue Blue-Bunch Wheatgrass	4	4	—	5
Ponderosa Pine Series	Ponderosa Pine Rough & Idaho Fescue Blue-Bunch Wheatgrass	3	6	—	6
Limber Pine Series	Limber Pine Rough & Idaho Fescue Blue-Bunch Wheatgrass Needlegrasses Grama Grasses	1	5	—	7
Timberline Series	None—Highest economic values are watershed and recreation	2	2	—	7

[1] Timber, livestock forage, and cropland productivity ratings are on a scale from 1 (low) to 10 (high). Recovery following disturbance is rated on a scale of 1 (fastest) to 7 (lowest).

TABLE 34. THREATENED OR ENDANGERED PLANT SPECIES WHICH MAY OCCUR WITHIN THE STUDY CORRIDORS

PLANT SPECIES	STATUS	DISTRIBUTION
Grindelia howelii Steyermark	Endangered[1]	Foothills of the Swan Range in the Clearwater Valley
Trisetum orthochaetum A. S. Hitchcock	Endangered[1]	One collection near Lolo Hot Springs in western Montana
Silene spaldingii Wats.	Endangered[1]	Rare taxon found in Sanders and Flathead County
Claytonia flava A. Nels.	Uncertain[1]	Possibly in northwestern Montana
Phlox missoulensis Wherry	Endangered[2]	In foothills north of Missoula city limits
Calamagrostis tweedyi (Scribn.) Scribn	Threatened[2]	Subalpine slopes and moist meadows in western Montana
Carex parryana Dewey	Threatened[2]	Moist low ground in the plains and foothills of eastern Montana
Rorippa calycina (Engelm.) Rydb. var. calycina (Suksd.) Rollins	Threatened[2]	Moist lowland areas in eastern Montana

[1] Watson (1976)
[2] Ayensu and DeFillips (1978)

reclamation effort would be required following pipe removal. In forest and shrub areas, the entire right-of-way would be revegetated with trees and shrubs.

MEPA Concerns

Construction-related damage to vegetation would be short term to the extent that revegetation would restore vegetation cover on the right-of-way, and also to the extent that land productivity is not impaired by soil compaction, horizon mixing, or other factors. Long-term vegetation impacts (those lasting the life of the facility or longer) would result from prevention of timber and shrub regrowth on the permanent right-of-way and permanent vegetation loss at pump stations and delivery facilities. Thus, significant (long-term) impacts to vegetation would result where the pipeline is constructed through forested areas, and where pump stations or delivery facilities are sited on forest land or cropland. These are adverse impacts which cannot be avoided, although the extent of timber productivity loss can be mitigated by adjustments in right-of-way width or by centerline siting along existing cleared rights-of-way. No irreversible or irretrievable loss of vegetative resources would result from the proposal, except that of lost land productivity during the pipeline operation phase.

Mitigating Measures

Location of the Pipeline and Associated Facilities

The potential for adverse impacts on vegetation would be reduced by:

1) Siting the pipeline and related facilities in areas where there is the least risk of damage to vegetation.
2) Evaluating the proposed centerline and the locations of the associated facilities, by on-the-ground inspection modifying them whenever practical to avoid sites of locally high impact risk.
3) Mapping and documenting in detail areas of high impact risk which cannot be avoided during centerline evaluation; these "environmentally sensitive areas" could be the focus of later mitigation during pipeline construction.

Construction Practices

Impacts to vegetation and land productivity would be minimized during construction by:

1) Prohibiting or restricting construction activities involving motorized travel at times when the soil is saturated with moisture, and when vehicles would cause extensive ruts, channels, or wind erosion.
2) Keeping to a minimum the amount of time spent in an area with saturated soils, when it must be crossed by motorized vehicles.
3) Limiting the cleared construction right-of-way to the minimum width necessary for efficient construction. This is especially important in forested areas where timber must be cleared. Chapter five describes considerations in determining right-of-way width.
4) Segregating the topsoil during trenching by double-ditching, and quickly replacing it to aid reclamation.
5) Preparing a plan of all proposed access roads before construction begins.
6) Limiting the width of access roads to that necessary for safe operation of equipment.
7) Adequately maintaining roads while they are in use, including promptly filling in all ruts made by machinery to prevent channeling of runoff and preventing wind and water erosion during and after road use
8) Strictly prohibiting unauthorized cross-country travel and development of unauthorized roads during construction. The contractor could be held liable for any damages resulting from unauthorized cross-country travel or road development by construction crews.
9) Conducting construction activities and travel to minimize dust pollution. Water, straw, wood chips, dust pallative, gravel, combinations of these, or similar control measures may be used. Oil or similar petroleum derivatives should be avoided.
10) Obtaining permission from the landowner or managing agency before cutting or destroying timber outside the right-of-way.
11) Felling all trees, snags, and other wood material cut during right-of-way clearing within the right-of-way and away from water courses.
12) Cutting all trees, snags, and other wood material during clearing so that stumps are not higher than 15 cm (6 in) from ground level on the uphill side.
13) Removing debris from clearing and construction that could be carried into streams.
14) Disposing of all slash in the construction corridor and along access roads.
15) Piling and windrowing burn material with tractors equipped with a forked clearing blade in a manner that would prevent destruction of vegetation and minimize erosion. If piles are small and compact, the danger of forest and grass fires would be minimized.
16) Preparing a detailed plan for material sites (such as gravel pits) along the route, and blending the site boundaries with the natural lines of the surrounding landscape.
17) Avoiding flood plains when locating material sites.
18) Minimizing construction of new roads, using existing roads wherever possible. If new access roads must be built, they could also serve permanent maintenance access requirements, subject to the desires of the landowners.
19) Planning all permanent maintenance roads before construction ends, and designing roads intended to be used as permanent maintenance roads as such.
20) Designing all roads to accommodate the largest piece of equipment that would eventually be required to use them.
21) Clearly marking the limits and location of access for construction equipment before any equipment is moved to the site, and training construction personnel to recognize these markers and understand the restrictions.
22) Constructing, where practical, temporary roads on the most level land available. Instead of grading or blading roads which cross flat land, flagging could mark their location.
23) Preserving shrubs during clearing of the right-of-way to the greatest extent possible, and using brush blades instead of dirt blades to minimize root disturbance when shrub removal is necessary.
24) Using selective clearing to make curved, wavy, or irregular boundaries along the right-of-way edges wherever appropriate. Where there is potential for long tunnel views of transmission lines or access roads, special care could be taken to screen the lines from view by judicious use of screen planting. Special care could also be taken to leave a separating screen of vegetation where the right-of-way parallels highways and rivers.
25) Not allowing, under any conditions, unqualified people to operate earth-moving equipment.
26) Not allowing motorized travel on, scarification of, or displacement of stabilized talus slopes.
27) Proposing a detailed fire plan for prevention, control, and extinguishing of fires on or near the right-of-way.
28) Having the contractor provide the necessary equipment for fire protection and control. Spark arresters and additional mufflers on some engines may be required in areas of high fire danger.
29) Storing blasting caps and powder only in approved areas and containers, and always separate from each other.
30) Proper storing and handling by the contractor of combustible material which could create objectional smoke, odors, or fumes; and burning refuse such as trash, rags, tires, plastics, or other debris only as permitted by the proper authority.

Reclamation

The most desirable right-of-way reclamation procedures would result in land uses and levels of vegetation productivity similar to uses and productivity before pipeline construction. Mitigation of adverse effects would be accomplished by the following measures:

1) Introduce species of grasses and shrubs which are suited to the site's environment when it is necessary to remove the natural vegetation for the duration of the project (for example, in forests).
2) Having a team of reclamation specialists formulate a site-specific reclamation plan before the construction begins. The plan could reflect consideration of a site's geology, soils, native vegetation, precipitation, and topography.
3) Considering soil characteristics when selecting suitable seed mixtures.
4) Identifying planting dates well in advance of pipeline construction and determining these dates by analysis of a site's seed requirements and seasonal precipitation patterns.
5) Planting seeds of nonnative annual species for temporary revegetation when construction ends at a time of year when seeds for native species cannot be planted. The introduced species would help stabilize the soil until the site could be seeded with a combination of native grasses and shrubs. The amount of each species seeded would depend on soil characteristics, precipitation, elevation, and the type of cover desired.
6) Taking steps to minimize soil erosion until vegetation is reestablished. Erosion could be temporarily controlled with sediment traps, berms, slope drains, toe-slope ditches, diversion channels, sodding, and mulching.
7) Beginning reclamation as soon as possible after construction ends, but not when soil moisture is high or when the ground is frozen. To permit initial reestablishment of vegetation, irrigation could be considered in areas threatened by drought.
8) Separating topsoil from subsoil and storing it separately, taking precautions to prevent wind and water erosion, and reestablishing the original contour of the land after the pipe is laid.
9) Using the soil's chemical and physical properties to determine the kind and amount of fertilizer and other soil amendments needed.
10) Seeding reclamation areas by the appropriate technique, determined by slope, soil characteristics, type of seed, and intended land use. Aerial seeding does not ensure distribution of the appropriate seed mixture on individual micro-environments. More desirable is drill seeding, hydroseeding or broadcast seeding with a minimum use of mechanized equipment. Covering seed and compacting the soil after planting is also desirable.
11) Using techniques of erosion and sedimentation control, such as mulching, to stabilize the soil or seed in some areas. Brush, logs, chippings, and other materials from the construction area could be used for mulch. Speedy revegetation may help to stabilize areas with excessive soil erosion. Planting shrubs or trees in containers near streambanks, where immediate stabilization is required, is desirable.
12) Disposing of construction debris in the manner that causes the least environmental damage.
13) Inspecting vegetated portions of the right-of-way periodically to evaluate the success of reclamation. Areas where vegetation is not reestablished could be reseeded or replanted. Regrading eroded surfaces or restoring the original contour before seeding is desirable.
14) Avoiding areas where there has been recent reclamation or where there is new growth to minimize damage from postconstruction traveling on the right-of-way. When it is necessary to enter reclamation areas, travel by foot or by vehicles with wide tires would minimize damage.
15) Using special techniques to reclaim centerline problem areas identified and mapped during centerline evaluation. These areas include: (1) areas with a short growing season, (2) soils with high salt content, (3) soils with a high shrink-swell potential, (4) steep slopes, (5) bedlands, and (6) scenic forested areas.
16) Replacing earth adjacent to access roads crossing streams at slopes less than the normal angle of repose for soil type involved.
17) Making detailed plans for revegetating each soil-geologic-vegetation zone along the pipeline route ninety days before construction. Plans could include species to be used, seed mixtures, seed sources, the season seed would be applied, and equipment that may be necessary.
18) Having seed and fertilizer on hand to ensure reseeding during the first possible planting dates after construction of each pipeline segment. Proof of purity, germination success, and content of inert materials in seed mixtures before their use is desirable. Some seeds of scarce grass species may have to be ordered at least a year before construction to ensure their availability when needed.
19) Employing hydroseeding, drilling, and seeding, and mulching with straw or woodchips where necessary to encourage revegetation.
20) Employing followup measures to ensure successful reclamation. The routine use of standard erosion-control and reclamation techniques could fail in problem areas unless repeated checks and followup reseeding, repair of erosion-control structures, and the like are done under the supervision of qualified soils and reclamation specialists. Nets, chemical binders, and mulches are commonly ineffective or last only a short time.
21) Posting of a bond (with the state) by NTPC, that would be refundable upon successful revegetation. Revegetation could be considered successful if the following criteria are met:

    a) In rangeland, canopy cover of perennial species of 30 percent or more of that of adjacent range the year following revegetation (except in certain areas identified during centerline studies), and 90 percent or more of adjacent range before the bond is refunded.

    b) Planting trees in forested lands (except those within the permanent right-of-way or land cleared for permanent roads), by the end of the bond period, with the level of stocking on cleared land approximating the level of stocking in adjacent areas by maturity.
22) Including in the reclamation plan a tightly defined procedure for measuring plant cover percentage for a statistical sampling of route segments differing in climate and soils. If effeciently designed, the actual field measurements of revegetation success would be rapid and cost-effective.

Pipeline Operation

Adverse impacts on vegetation during pipeline operation would be reduced by:

1) Limiting the width of the permanent right-of-way in forest or shrub land areas to the minimum necessary to allow surveillance and access for maintenance and oil spill cleanup machinery.
2) Using mechanical methods rather than herbicides to control vegetation.
3) Avoiding broadcast spraying of herbicides at pump stations and delivery facilities.
4) Minimizing the amount of clearing. A clearing plan could be prepared outlining schedules and methods which minimize vegetation damage.
5) Timing maintenance inspections to ensure that maintenance would occur when access roads are firm. Vegetation removed for maintenance could be cleared mechanically; in areas susceptible to damage from clearing, mechanical clearing could be limited to only short periods.
6) Preparing a fire plan with detailed provisions for preventing, controlling, and extinguishing fires within or near the right-of-way.
7) Adopting an integrated weed control plan for right-of-way maintenance which avoids weed control by broadcast application of herbicides.

Oil Spills

Mitigation of adverse impacts to vegetation due to oil spills would be accomplished by:

1) Controlling, removing, and disposing of any oil that is discharged from the pipeline during any phase of the project.
2) Identifying emergency access routes for oil spill cleanup equipment in advance, avoiding when possible wet areas, steep slopes (over ten percent),

water courses, forests, compactable or erodible soils, and areas subject to wind erosion. A buffer zone of at least 30 m (100 ft) next to watercourse would reduce adverse impacts.

3) Determining the soil type of the spill area by sampling both contaminated and uncontaminated soil at a depth of 30 cm (12 in) and analyzing nutrients and oil content.
4) Testing soils to determine the amount and kind of fertilizer needed. Fertilizer could be applied with a broadcast spreader and mixed into the contaminated soil.
5) Periodically testing contaminated soils, with the length of time between tests dependent on precipitation and temperature which influence microbial activity.
6) Revegetating the site when analyses indicate the oil content of the soils has stabilized and the demand for nutrients has decreased. Agricultural land could initially be revegetated with wheat or oats, because these crops can tolerate oil-contaminated soil better than other crops. After agricultural land is successfully revegetated with a wheat or oat crop, other crops could be planted.
7) Revegetating grasslands by seeding the spill area with a rapidly growing annual, and then seeding with species similar to other species in the area.
8) Continuously monitoring the spill areas to determine the success of revegetation. Areas where reclamation is not successful could be refertilized and reseeded, and sod could be placed on sites where seeding would be difficult.
9) Revegetating with native plants that have successfully grown on forested sites where oil has spilled, since the success of revegetation also depends on the species used to revegetate. Revegetation of forested areas would generally be more complex and difficult than revegetation of agricultural areas and grasslands; in some forested areas, soils are not developed and conditions are not conducive to microbiological degradation of oil.

WILDLIFE AND HABITATS

The study corridors for the proposed Northern Tier Pipeline cross a variety of habitats, from the semiarid steppe of the eastern plains to subalpine and timberline forests in the western mountains. Consequently, most species of animals found in Montana occur at least seasonally within the corridors. Species lists and general inventory data for these terrestrial vertebrates are available in the reports of: Hall and Kelson (1959), Hoffmann and Pattie (1968), and Hoffmann et al. (1969a and b) for mammals; Davis (1961) and Skaar (1975) for birds; Black (1970) for amphibans; and Black and Black (1971) and Davis (1963) for reptiles (see also Flath 1978a & b). These data are readily available and need not be repeated in this document.

The significance of potential impact to wildlife is considered in terms of measurable, long-term changes in carrying capacity of the environment (or optimum long-term numbers) (Sharma et al. 1975). For example, if one hundred ground squirrels or western meadowlarks should be destroyed during pipeline construction, the impact to the total population would be short term and not significant, because the populations would recover quickly and carrying capacity would not be affected. If five osprey or five moose were destroyed during construction, the impact could be long term and much more significant, since these species are relatively scarce and have lower recovery rates; however, carrying capacity would still not necessarily be affected. Should nesting habitat for the osprey be destroyed or willow bottoms on moose winter range reduced, the impact to these populations would be long term, and carrying capacity would be reduced. A negative or adverse impact to a population of a particular species may therefore be defined as an environmental change which (1) reduces population size below the existing carrying capacity of the environment, (2) increases population size above carrying capacity, or (3) reduces existing carrying capacity. A positive impact may be defined as an environmental change which (1) restores depleted or oversized populations to carrying capacity, or (2) increases carrying capacity.

A listing of wildlife species, populations, communities, or habitats which could be significantly affected by the proposed pipeline was prepared using criteria which considers both the relative value and the relative vulnerability of wildlife species; thus, an animal which is of relatively minor importance, but which could be seriously affected by the proposal, can be of greater concern than an important species which would not be affected at all. Since there was no time for field work, the availability of wildlife data also was considered in deciding which species can be considered. The list of species and areas of concern is presented in table 35; this list also served as the legend for inventory mapping and provided the criteria for tabular, quantitative comparison of routes (see chapter seven).

Areas of highest impact risk to wildlife and habitat are shown on map 8, p. 86. See **Northern Tier Report No. 2** for further discussion of the following impacts.

Impacts

It is convenient to group potential impacts to wildlife into four categories: (1) habitat alteration, (2) displacement, (3) changes in birth or death rates, and (4) stress. Complex relationships exist among these four impact categories and their ultimate effect upon carrying capacity. Each impact may be either positive or negative, depending upon circumstances and the nature of the particular species involved, and may be short term (temporary) or long term (persistent or permanent). Impacts resulting from the actual act of pipeline construction would generally be short term; those resulting from the physical presence of the pumping station, cleared rights-of-way, and access roads would be long term and would affect animal populations as long as the facility exists.

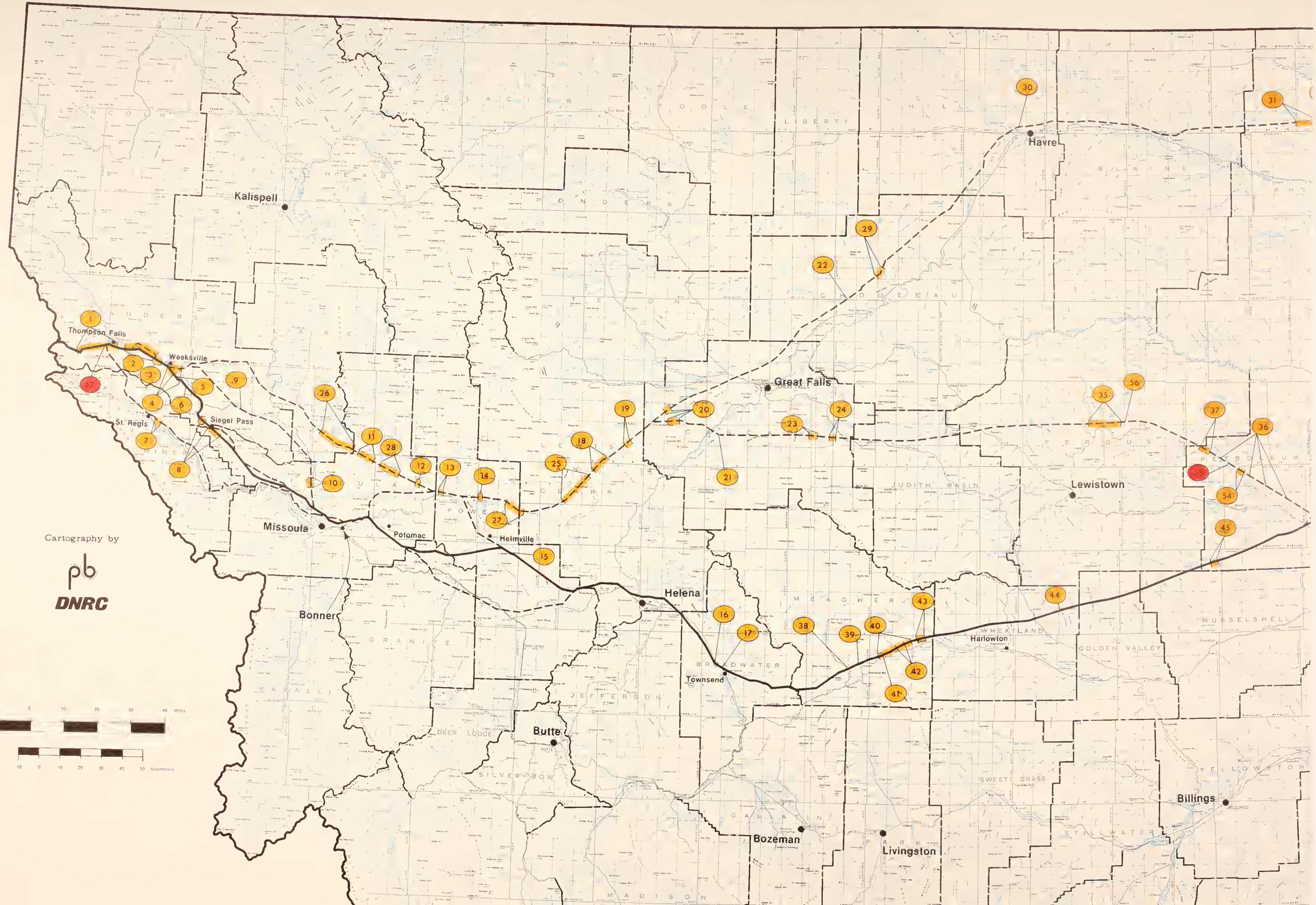
Habitat Alteration

A number of pipeline-related activities may result in the direct alteration or removal of wildlife habitat; this could affect carrying capacity for many species (see **Northern Tier Report No. 2**). Construction camps, barrow pits, airstrips and helicopter pads, river crossings, stockpile sites, pump stations, delivery facilities, communication sites, permanent roads, drainage alteration or the siltation and enrichment of aquatic habitats, and right-of-way clearing and trenching may markedly affect habitat. For example, construction of seven pump stations and two delivery facilities in Montana would destroy a minimum of 59 ha (145 acres) of habitat.

Removal of vegetation during construction would affect nearly all species using the area, primarily by affecting food and cover availability. Most affected would be species requiring timber cover (such as elk, deer, pine marten) or tall shrubs (sage grouse, ring-necked pheasant). The most significant impact may be expected from removal of scarce and important patches of vegetation; isolated groves of trees used as nest sites; dense, tall sagebrush stands important to wintering antelope and sage grouse; willow bottoms important to moose; riparian shrubbery, cottonwoods, snags, and wetlands. Species adapted to climax or near-climax situations, including the marten, fisher, pileated woodpecker, and wolverine, often have specific habitat requirements and would be especially vulnerable to habitat loss. "Wilderness" species, such as the grizzly bear, wolverine, and mountain lion, would be adversely affected by fragmentation of large blocks of unroaded forest land; elk populations would likely decline if important summer security areas were similarly fragmented.

A commonly cited impact of forest clearing is the resultant increase in production of seral shrubs and forbs, which may provide food for a variety of herbivores as well as cover for small mammals and birds. The extent of shrub regeneration would depend on a number of site-specific factors. Its usefulness to larger herbivores (such as deer and elk) would depend on accessible cover, local habitat preferences, and animal use patterns, availability of food in surrounding areas, and the amount of nearby disturbance. Clearing or burning of certain forest types, particularly moist sites having a shrubby understory, could increase browse production. Clearing of drier forest types would probably produce little additional forage. Deer and elk would likely benefit from increased forage production

MAP NO. EIGHT



Kalispell
Havre
Great Falls
Lewistown
Missoula
Potomac
Helmville
Helena
Bonner
Townsend
Harlowton
Butte
Bozeman
Livingston
Billings
Thompson Falls
Weeksville
St. Regis
Siegel Pass
LINCOLN
SANDERS
LAKE
FLATHEAD
GLACIER
TOOLE
LIBERTY
HILL
BLAINE
PONDERA
TETON
CHOUTEAU
LEWIS AND CLARK
CASCADE
JUDITH BASIN
FERGUS
PETROLEUM
MINERAL
MISSOULA
POWELL
MEAGHER
WHEATLAND
GOLDEN VALLEY
MUSSELSHELL
GRANITE
RAVALLI
DEER LODGE
SILVER BOW
JEFFERSON
BROADWATER
GALLATIN
PARK
SWEET GRASS
STILLWATER
YELLOWSTONE
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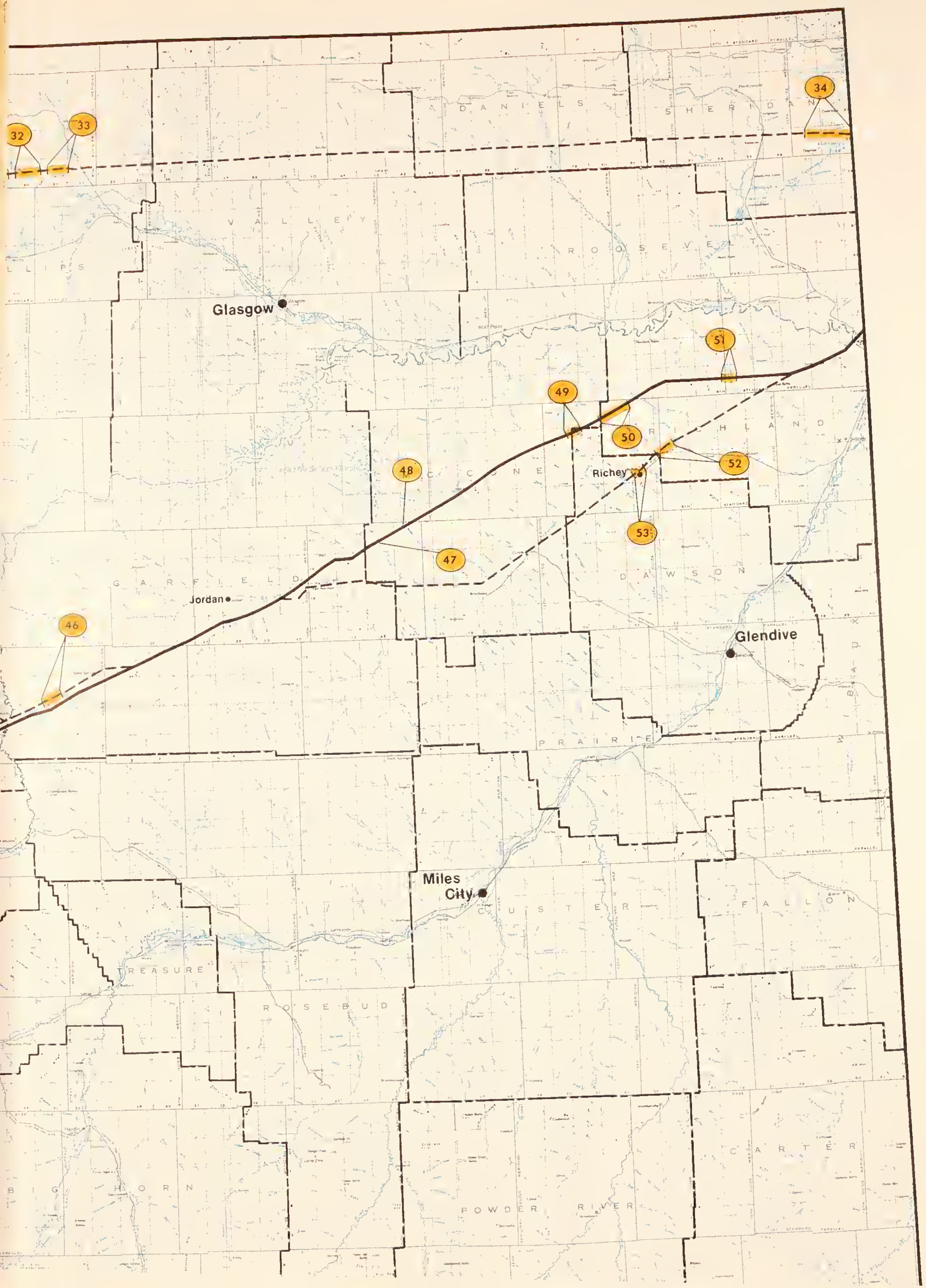


MAP NO. EIGHT

WILDLIFE AND HABITATS

Critical Area
Sensitive Area

NO.	DESCRIPTION
1.	White-tailed deer*
2.	Bighorn Sheep* Potential prairie falcon nesting habitat
3.	Mule deer* Elk*
4.	White-tailed deer* Possible bald eagle nest
5.	Probable bald eagle nest
6.	Probable bald eagle nest Probable prairie falcon nest
7.	Elk*
8.	Elk summer security area
9.	Great blue heron rookery
10.	Grizzly bear habitat
11.	Grizzly bear habitat
12.	White-tailed deer* Possible bald eagle nest
13.	Bald eagle nest
14.	White-tailed deer*
15.	Osprey nest
16.	Two osprey nests
17.	Great blue heron rookery Double-crested cormorant rookery
18.	Mule deer* Elk*
19.	Pronghorn*
20.	Pronghorn*
21.	Pronghorn*
22.	Mule deer*
23.	Mule deer*
24.	Mule deer*
25.	Proposed critical grizzly bear habitat
26.	Proposed critical grizzly bear habitat
27.	Proposed critical grizzly bear habitat
28.	Grizzly bear habitat
29.	Mule deer*
30.	Great blue heron rookery
31.	Mule deer*
32.	Mule deer* Pronghorn*

NO.	DESCRIPTION
33.	Pronghorn*
34.	Medicine Lake: watertowl habitat, whooping crane habitat
35.	Mule deer* White-tailed deer* Pronghorn* Excellent sharp-tailed grouse habitat with many leks
36.	Sage grouse prime habitat with four leks within one kilometer
37.	Pronghorn*
38.	Sage grouse prime habitat, lek within one kilometer
39.	Golden eagle nesting area
40.	Mule deer* Golden eagle nesting area
41.	Golden eagle nesting area
42.	Elk* Golden eagle nesting area
43.	White-tailed deer*
44.	Sharp-tailed grouse dancing ground
45.	Pronghorn* Great blue heron rookery within one kilometer
46.	Pronghorn*
47.	Prairie dog town
48.	Prairie dog town Sage grouse strutting grounds
49.	Pronghorn*
50.	Mule deer*
51.	Pronghorn*
52.	Pronghorn*
53.	Mule deer*
54.	Pronghorn* Sage grouse critical winter habitat
55.	Critical area—pump station 5R Mule deer*
56.	Sharp-tailed grouse lek
57.	Critical area—pump station 1K White-tailed deer*

*Concentration areas during severe winters

on winter ranges, but probably would not appreciably benefit from increased production on summer-fall ranges where food may already be abundant. Availability of the forage produce must also be considered. Large herbivores would not benefit by abundant browse in inaccessible areas or areas avoided because of disturbances such as pump stations or delivery facilities. For large herbivores, the availability of browse is partially dependent upon distance from cover; elk in particular are reluctant to venture far from tree cover into large clearcuts, in spite of abundant browse. Several studies have shown that in uniform stands of certain forest types, removal of trees in narrow strips (such as rights-of-way) can be more beneficial to herbivores than removal of timber in large blocks, because the forage is available a short distance from cover. Since site-specific factors are of key importance, however, no generalizations can be made about the effects of the proposed pipeline on big game forage production.

Creation of ecotones or forest edges by right-of-way clearing would likely increase densities of open-canopy or forest edge species, while reducing densities of closed-canopy or late-successional species. The overall effect of pipeline-related edge on wildlife diversity, density, or productivity in Montana forests is unknown, but it probably would not be significant. Removal of nest trees used by raptors, herons, or cavity-nesting birds may reduce carrying capacity if no other suitable nest sites exist nearby.

Long stretches of open trench or welded sections of pipe could create a barrier to movements or migration of ground-dwelling species. This would be most important in cases where a construction spread separated summer from winter range at a time when animal movement was in progress. Other habitat alteration may result from siltation of vegetation due to wind-blown dust, from discharge by hydrostatic testing water, or from oil spill effects on soils and vegetation.

Displacement

Displacement—population redistribution resulting from disturbance or other environmental change—is a special case of habitat alteration which causes animals to avoid an otherwise suitable area.

TABLE 35. WILDLIFE SPECIES AND AREAS OF CONCERN, NORTHERN TIER PIPELINE STUDY AREA

SPECIES OR SPECIES GROUP	STATUS	AREAS OF CONCERN	HABITAT CHARACTERISTICS	SUMMARY OF PROBABLE PIPELINE-RELATED IMPACTS
Double-crested Cormorant	Nongame	Nesting colonies	Tall cottonwoods near large bodies of water	Abandonment of nesting colonies due to harassment or habitat loss, shooting of birds
Great Blue Heron	Nongame	Nesting colonies	Tall cottonwoods near large bodies of water	Abandonment of nesting colonies due to harassment or habitat loss, shooting of birds
Waterfowl	Migratory Game	Total and "excellent" habitat'	Prairie potholes, stock ponds, major rivers	Loss of or oil contamination of nesting habitat
Golden Eagle	Nongame	Nesting areas	Low-elevation cliffs near sagebrush, grassland	Abandonment of nesting areas due to harassment; shooting of birds
Bald Eagle	Endangered	Nesting areas	Tall snags near large bodies of water	Abandonment of nesting areas due to harassment; shooting of birds (NOTE: no pipeline-related impacts are anticipated near wintering areas within the study area); loss of nesting habitat
Osprey	Nongame	Nesting areas	Tall snags near large bodies of water	Abandonment of nesting areas due to harassment; shooting of birds; loss of nesting habitat
Prairie Falcon	Nongame	Nesting areas	High cliffs near sagebrush, grassland	Abandonment of nesting areas due to harassment; shooting of birds; loss of nesting habitat
Peregrine Falcon	Endangered	Nesting areas	High cliffs near water areas	Abandonment of nesting areas due to harassment; shooting of birds; loss of nesting habitat (NOTE: no active eyries are known to occur within the study area)
Mountain Grouse	Game	Total habitat	Variable; includes conifers, aspen groves, grassland, shrubland	Habitat alteration due to right-of-way clearing or pump station sites
Sharp-tailed Grouse	Game	"Excellent" habitat,' dancing grounds	Grassy knolls near shrubland	Abandonment of leks due to harassment; shooting of birds
Sage Grouse	Game	Strutting grounds	Grassy openings in sagebrush	Abandonment of leks due to harassment; shooting of birds
		Total and critical winter habitat	Sagebrush; especially dense, tall sagebrush which is not buried by snow during severe winters	Habitat loss due to right-of-way clearing or pump station sites
Ring-necked Pheasant	Game	Total Habitat	Dense shrubbery near grainfields	Habitat loss due to right-of-way clearing or pump station sites

Temporary disturbances associated with work camps and construction (such as noise, surveying, forest clearing, dust, trenching, or pipe laying) would cause a short-term displacement of most birds and mammals. The animals would move away from the disturbance, but return after a period of time. The actual distances moved and the amount of time before return—two factors determining the severity of impact—would depend on the habits of the species involved as well as the type, distance, and severity of disturbance. The avoidance of logging and road construction by large ungulates, especially elk and moose, is well documented. For elk, this displacement may be evident up to 6.4 km (4 mi) from the disturbed site. Noise from blasting and operation of heavy equipment would displace most wildlife species for a least a short period of time. Noise levels from typical construction activities can be as high as 78 to 84 decibels at 120 m (400 ft).

If construction occurs during the breeding season, it is likely that all active bird nests would be abandoned—and hence the current season's production lost—within the right-of-way as well as within a strip of land extending an undetermined distance on either side (see table 36, p. 90). Breeding birds notably raptors and colonial water birds, may abandon eyries or rookeries if displaced early in the breeding season; sage and sharptail grouse may abandon historical display grounds. Even if breeding sites are not permanently abandoned, flushing incubating or brooding adults from nests may result in loss of young due to exposure or premature fledging. With these exceptions, the overall impact of short-term displacement upon carrying capacity would generally be insignificant. Once construction ends, displaced animals would eventually resume normal activity, insofar as habitat alteration allows.

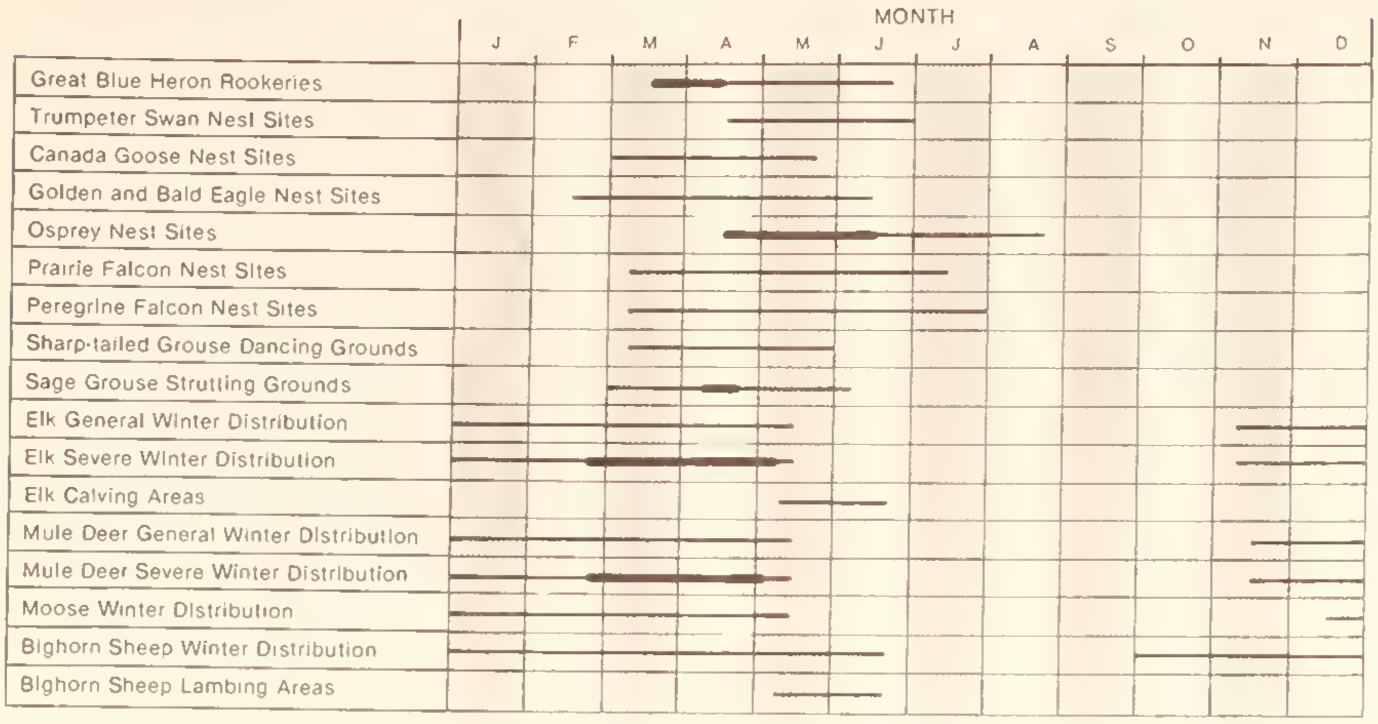
A more serious type of impact is long-term displacement, or permanent avoidance of a disturbed area. Such avoidance would be equivalent to a permanent reduction in carrying capacity because previously used habitat becomes unavailable. Long-term displacement may result from (1) the avoidance of noise at pump station and delivery facilities and (2) the avoidance of roads and vehicular traffic.

TABLE 35. (cont.)

SPECIES OR SPECIES GROUP	STATUS	AREAS OF CONCERN	HABITAT CHARACTERISTICS	SUMMARY OF PROBABLE PIPELINE-RELATED IMPACTS
Whooping Crane	Endangered	Stopping-over areas along migration path	Wetlands	Contamination by oil from a major spill in wetlands
Grizzly Bear	Threatened	"Critical" Habitat[2]	Remote mountainous areas with conifers, grassland, scree and talus	Mortality as a result of encounters with construction crews; displacement due to construction noise
Black-footed Ferret	Endangered	Likely habitat	Prairie dog towns	Habitat loss due to right-of-way clearing or pump stations sites; shooting
Elk	Game	Winter range; areas of concentration during severe winters	Wind-swept grassland or shrubland slopes near timber cover	Habitat loss due to right-of-way clearing or pump sites; increased stress due to harassment; displacement due to construction noise or traffic on access roads
		Summer-fall security areas	Dense, moist coniferous habitat types near heads of drainages	Long-term displacement due to traffic on access roads; fragmentation habitat
Mule Deer	Game	Winter range; areas of concentration during severe winters	Wind-swept shrubland near timber cover or coulees	Habitat loss due to right-of-way clearing or pump sites; increased stress due to harassment; displacement due to construction noise or traffic on access roads
White-tailed Deer	Game	Winter range; areas of concentration during severe winters	Forests with dense shrub understory, especially near cropland	Habitat loss due to right-of-way clearing or pump sites; increased stress due to harassment; displacement due to construction noise or traffic on access roads
Moose	Game	Winter ranges	Willow bottoms	Loss of winter food source due to right-of-way clearing
Pronghorn	Game	Winter range; areas of concentration during severe winters	Dense, tall sagebrush which is snow-free even during severe winters	Habitat loss due to right-of-way clearing or pump sites; increased stress due to harassment; displacement due to construction noise or traffic on access roads
Bighorn Sheep	Game	Winter ranges	Low-elevation cliffs and adjacent grassland, shrubland	Displacement due to construction noise or traffic on access roads; increased stress due to harassment

[1] "Excellent" habitat as mapped by DFWP (unpubl.)
[2] "Critical" habitat as defined by the USDI Fish and Wildlife Service (1976)

TABLE 36. PERIODS WHEN SELECTED SPECIES ARE MOST SENSITIVE TO DISTURBANCE OF SEASONAL USE SITES IN MONTANA



Periods of greatest sensitivity to disturbance are shown by heavier lines

Avoidance of noise, human activity, yard lights, access roads, and vehicular traffic may effectively reduce the amount of habitat available near pump stations. Although posted or not maintained, roads created for construction access are often used by hunters, motorcyclists, snowmobilers, or other recreationists. This may also result in long-term displacement of species which avoid human activity. Many studies have documented elk avoidance of roads, but others suggest that freeway traffic has little effect on elk activity beyond 0.3 km (0.2 mi). Also, many logging roads avoided during daylight hours when traffic is present are freely crossed at night. The sensitivity of elk to disturbance would depend largely on the season and on the condition of the animal. Other big game mammals, including moose, mountain goats, and deer, are also known to avoid roads and associated human activity.

Dispersed recreation and off-road vehicular travel, especially snowmobile use of the cleared right-of-way, may also result in displacement of large ungulates. Deer can become accustomed to light, constant snowmobile activity, but react violently to snowmobile invasions into new areas. Elk appear less tolerant of snowmobiles and will move relatively great distances to escape the disturbance. Goodwin (1975) reports increased hunter use of the right-of-way and access roads of a 500-kV transmission line in Idaho was the major negative impact on big game animals observed during his study. Hunters tended to concentrate along roads, trails, and clearings, and seldom hunted more than 1.6 km (1 mi) from a road or clearing. This increased hunting pressure was found to displace elk to areas 0.8 km (0.5 mi) or more away from the right-of-way or access roads.

Many wildlife species can become habituated to disturbances if they are constant; however, if the routine in disrupted, as in the case of infrequent or irregular use of rights-of-way and access roads, there would be little opportunity for habituation or conditioning to disturbance. The resulting long-term displacement can greatly reduce the amount of habitat acceptable to certain wildlife species—a possible net reduction in carrying capacity (see **Northern Tier Report No. 2**).

Changes in Birth and Death Rates

Minor variations in natural mortality rates are normally masked by overproduction of young or, in some cases, by increases in birth rates, so most animal populations are regulated at or near carrying capacity. Increased mortality is a serious impact only when it exceeds the population's potential for recovery. If continued for long periods of time, this can result in local or regional extinction. Populations most likely to be adversely affected by increased mortality are: (1) species with a low reproductive potential, such as the grizzly bear, peregrine falcon, and trumpeter swan; (2) species which are already rare or in danger of extinction, such as the black-footed ferret; and (3) species living in isolated colonies which can be easily eliminated, such as the great blue heron. Small mammals and other species with high reproductive potential are adapted to high natural mortality rates; often, high mortality can be compensated for in a few months or years. The proposed pipeline may contribute to increased mortality rates or decreased birth rates of some species in several ways. Direct mortality of many reptiles, amphibians, nesting birds, and small mammals would likely result from blasting, clearing, and trenching of the right-of-way. Illegal shooting by construction personnel may be a major impact to raptor and big game populations. Increased human activity in previously inaccessible forested areas could result in changes in harvest rates for fur-bearers and big game species. Oil spills could destroy members of many species through soaking of fur or feathers or through contamination of food sources; semiaquatic mammals, waterfowl, herons, shore birds, and fish-eating raptors (such as the osprey and bald eagle) would probably be significantly affected in the event of a pipeline failure.

Stress

Stress may increase because of displacement or habitat alteration, and may indirectly affect death and birth rates. For example, repeated displacement of wintering elk into areas of deep snow is not likely to kill the animals; but it may cause abortions or increase the potential for predation, disease, or starvation. Even slight increases in stress and the expenditure of stored energy are important during winter, when most animals are already under severe stress. Harassment of wintering big game by construction workers or by aircraft during aerial surveillance would cause additional stress. Feeding of animals by construction workers or at garbage dumps may impose dietary stress or cause populations to be artificially increased above carrying capacity.

MEPA Concerns

An impact must be long term (affecting populations for several years and thus persistent beyond the pipeline construction phase) to be significant. Therefore, of the possible impacts of the Northern Tier Pipeline discussed above, those that could be significant are: (1) long-term habitat alterations resulting from prevention of regrowth of trees and shrubs on the permanent right-of-way; (2) intrusion of the right-of-way or access roads into roadless security areas; (3) long-term habitat alteration resulting from pump station and delivery facilities; (4) permanent abandonment of special-use sites (raptor nests, sage grouse strutting grounds, sharp-tailed grouse dancing grounds, large water bird colonies) due to pipeline construction and maintenance; and (5) major oil spills in wetlands during periods of heavy use by water birds. All of these must be considered at least partly mitigable by centerline location, construction timing, or construction methods, **except** for habitat loss at pump stations and delivery facilities.

No irreversible or irretrievable impacts to wildlife or habitats are expected to directly result from the Northern Tier proposal; no species or populations would be driven to extinction, and even pump station sites could theoretically be reclaimed after pipeline abandonment. Certain impacts which may result indirectly from the pipeline, however, may cause irreversible habitat alteration; these are related to possible changes in patterns of transportation or human residence encouraged by the increased availability of crude oil in Montana.

Mitigating Measures

Location of the Pipeline and Associated Facilities

Adverse impacts of the Northern Tier Pipeline on wildlife and wildlife habitats would be reduced by:

1) Whenever possible, routing the pipeline to avoid areas where wildlife populations would be adversely affected.
2) Having a biologist make an on-the-ground inspection of the proposed centerline and, whenever practical, modifying the centerline to avoid sites where there would be a high risk of adversely impacting wildlife. Factors to be considered in determining the significance of impacts from different centerlines include the biological and social importance of the species that would be impacted, the long-range implications of disturbing different areas, the susceptibility of different species to disturbance, and the extent to which impacts could be reduced by taking other actions besides relocating the centerline (e.g., by carrying out construction during a season when wildlife would be least affected).
3) Identifying environmentally sensitive areas through field investigation, preparing detailed maps for sensitive areas that cannot be avoided in centerline selection, and making efforts to mitigate impacts in these sensitive areas during pipeline construction.
4) Whenever possible, not locating powerlines, pump stations, delivery facilities, and access roads in environmentally sensitive areas.

Timing of Construction and Maintenance

Adverse impacts would be mitigated by:

1) Planning construction and maintenance to take place when they would cause the least damage if environmentally sensitive areas cannot be avoided. Such periods of time (called "construction windows") can vary in length from days to weeks to most of a year, depending on the species and the nature of its use of a given area. Table 36 shows the months when selected Montana wildlife species are most sensitive to pipeline-related disturbance and construction impacts could be critical. Timing of construction and maintenance would be especially important in calving, lambing, and fawning areas, and in nesting areas and strutting grounds.
2) Taking measures to speed construction in some environmentally sensitive areas (such as near bald eagle nesting sites). This could be done by working 24 hours a day, with double or triple shifts; welding pipe away from the construction sections; shortening construction sections; and hiring additional construction workers.
3) Not allowing trenching and welding through migration routes of large mammals (especially routes between summer and winter range) during periods of migration.

Construction Practices

Adverse effects of construction on wildlife would be mitigated by:

1) Limiting the width of a construction right-of-way to the minimum that would allow expeditious construction; this would be especially important in forested areas, where right-of-way clearing would generally require removal of timber for the life of a pipeline project. Chapter five describes the factors that would influence the required width of a right-of-way.
2) Limiting the number of new access roads to the minimum required to construct a pipeline system.
3) Designing and constructing the necessary new roads to cover the shortest distance possible without compromising engineering and construction standards (such as erosion control).
4) Operating construction equipment and other vehicles only on roads and within the right-of-way.
5) Clearing vegetation by hand rather than with machines in certain environmentally sensitive areas (such as nesting sites of raptors).
6) Making an on-the-ground inspection to approve clearing boundaries before clearing begins.
7) Clearing only vegetation within the clearing boundaries, except designated trees that would pose a hazard during construction or maintenance.
8) Creating an irregularly shaped edge, rather than a straight line, when clearing the right-of-way in forested areas that provide important big game habitat.
9) Disposing of all slash within the right-of-way or along access roads before the end of the first winter after clearing.
10) Removing debris generated by clearing and construction that might block wildlife movement.
11) Leaving earthen bridges over a trench at specified intervals during trenching to allow passage of wildlife. (This could be done by leaving narrow strips across a trench undisturbed until pipe is actually laid or by digging the trench, filling in bridges until the pipe is laid, and then reexcavating the bridge. This process in known as "skip trenching.")
12) Leaving openings at least 10-m (33-ft) wide at specified intervals between sections of welded pipe if it is left above ground for longer than a few days.
13) Quickly disposing of all garbage generated during construction, operation, maintenance, and abandonment of a pipeline system in a manner that would not attract wildlife.
14) Prohibiting the feeding of animals at construction areas, work camps, and other pipeline facilities.
15) Prohibiting the harrassment of wildlife along the pipeline corridor and at pipeline facilities.
16) Taking steps to mitigate damage to soils and vegetation in wildlife habitat.
17) Prohibiting possession of firearms by construction personnel on and near the right-of-way.

Reclamation and Revegetation

These steps would reduce long-term damage to wildlife and habitat:

1) Reclaiming and revegetating disturbed wildlife habitat as quickly as possible after construction ends, without jeopardizing the success of effort. The rapid reestablishment of native species would be especially critical in winter range. (See **Northern Tier Report No. 1** for discussion of mitigating measures that would encourage successful reclamation and revegetation.)
2) Whenever possible, revegetating the right-of-way in a manner that would maximize benefits to species of concern (for example, by giving priority to reestablishment of browse species important to herbivores in areas where the centerline crossed winter range).

Pipeline Operation and Maintenance

Adverse effects of operation and maintenance would be mitigated by:

1) Limiting the permanently cleared right-of-way through forested or shrubbry areas to the minimum width required to allow access for maintenance and oil spill cleanup.
2) Using mechanical methods for clearing and preventing regrowth of trees and tall shrubs within the permanent right-of-way.
3) Clearing only the minimum amount of vegetation necessary to accommodate operation and maintenance.
4) Clearing as quickly as possible in areas susceptible to damage from mechanical clearing.
5) Preparing a plan with detailed provisions for preventing, controlling, and extinguishing fires within and near a permanent right-of-way.
6) Closing pipeline access roads to public use by installing heavy gates.
7) In some environmentally sensitive areas (especially winter ranges of ungulates and nesting sites of peregrine falcon and bald eagles), making flights over the right-of-way at altitudes above 305 m (1,000 ft).

Oil Spills

Adverse effect from oil spills would be mitigated by:

1) Having NTPC's "Oil Spill Contingency

Response Plan" reviewed and approved before pipeline operation.

2) In the event of a spill, these measures would reduce the impact on wildlife:

a) Controlling, removing, disposing of, and cleaning up spilled oil to the satisfaction of the landowner or managing agency.

b) Rehabilitating oil-soaked birds and mammals immediately following a major oil spill, if rehabilitation would be cost-effective in terms of its overall effect on populations.

c) If rehabilitation would not be cost-effective, quantifying and compensating losses by enhancing habitat or employing some other form of compensation.

d) Quickly restoring the vegetation of a spill area (Mitigating measures for revegetation of a spill area are discussed in **Northern Tier Report No. 1**).

Abandonment

Measures that would mitigate adverse impacts on wildlife from abandonment of a pipeline are generally the same as those listed under "Construction Practices" and "Reclamation and Revegetation".

Compensation of Losses

Even if the most successful reclamation techniques and other methods of mitigating adverse impacts to wildlife were employed, a certain amount of damage might be unavoidable. Unmitigated losses, however, need not be a cost of development; in many cases, such losses can be compensated by enhancing habitat in one area to make up for losses in another. For instance, important wildlife habitat could be acquired off-site and managed to compensate for any pipeline-related losses.

Compensation could yield greater and more cost-effective benefits to wildlife than would mitigation. For instance, in its "Oil Spill Contingency Response Plan," NTPC proposes an elaborate and expensive program for rehabilitation of birds contaminated with oil. Rehabilitation of five hundred puddle ducks using NTPC's approach would cost over $12,000, not including the costs of pickup, transport, pens, rent, and transportation of personnel. Even with experienced personnel, survival rates of rehabilitated birds are seldom over 50 percent, and "it has not yet been clearly demonstrated that a significant number of released birds survive for more than a short period of time" (Mattoon 1977). Therefore, while oil-bird rehabilitation efforts are well-intentioned, they may not always be cost-effective. Compensation could be a more cost-effective means of dealing with oil spill losses. If NTPC's plan would include criteria by which the probable cost-effectiveness of rehabilitation could be determined, steps could be taken for rehabilitation only if it were cost-effective in terms of overall effects on populations. In many cases the time, money, and effort that would be spent on mitigation would be better spent on compensation such as habitat enhancement or management for waterfowl in another area (see **Northern Tier Report No. 2**).

Compensation of adverse impacts to wildlife that are unavoidable even with use of the best reclamation techniques by:

1) Preparing a management plan prior to construction which:

(a) identifies opportunities for enhancing habitat disturbed by pipeline construction and

(b) takes into account the specific wildlife species, habitats, terrain, climate, and other conditions found in particular areas along the route.

2) Monitoring construction to ensure that all mitigating measures are enforced and to allow documentation of unmitigated losses. Unavoidable losses could then be compensated by:

(a) purchasing or leasing habitat similar to the damaged habitat,

(b) managing areas other than the damaged area for the benefit of the affected species,

(c) obtaining easements to manage private land for the benefit of the affected species, or

(d) restocking the vacated habitat.

3) Estimating the requirements for compensating habitat losses on the basis of U.S. Fish and Wildlife Services Habitat Evaluation Procedures (Schamberger and Farmer 1978) or a modification of these procedures.

4) Enhancing habitat altered by pipeline construction through management. For instance, using spoils materials unsuitable for backfill to create nesting islands in reservoirs (see **Northern Tier Report No. 2**).

CLIMATE AND AIR QUALITY

The climate along the proposed and alternative pipeline routes ranges from a modified Pacific type near Montana's western border to a Continental type in the eastern two-thirds of the state. Pacific air masses keep western Montana temperatures more uniform than temperatures in the rest of the state; both the warmest summers and the coldest winters are found in the east.

Western Montana's complex terrain contributes to low wind speeds, low mixing heights, and high inversion frequencies, causing restricted pollution dispersion.

Central Montana consists of plains, broad valleys, and scattered mountain ranges. Surface winds in this area are generally the strongest in the state and are less influenced by topography than winds in western Montana. The high wind speeds and mixing heights, along with the low inversion frequencies and fairly open terrain, suggest that central Montana has some of the best pollution dispersion conditions in the state.

Winds in eastern Montana are fairly uniform because of the relatively flat terrain. Wind speeds are moderately high, but not as high as in central Montana. Pollution dispersion potential in eastern Montana is significantly better than in western Montana; however, it is generally not as good as in central Montana because of lower wind speeds, lower mixing heights, and greater inversion frequencies.

Throughout Montana, the air quality varies from pristine in remote, undeveloped regions, to levels exceeding national ambient air quality standards in several populated and industrial areas. Along the study corridors the air quality is largely unmeasured. Several designated Prevention of Significant Deterioration (PSD) class I areas near the corridors are addressed in chapter seven and appendix H.

Climatic Impacts

It is improbable that there would be any long-term impacts on climate from the proposed project; any that may occur would be localized and hardly detectable. Of greater concern are the possible impacts of climate on the construction and operation of the pipeline. The climatic features which may affect dispersion of pollutants produced by these activities are also a consideration.

The relatively low emissions expected from this project should have negligible impact on the climate of the area. Aerosols (i.e., liquid or solid suspended particulates) can affect atmosphere temperature characteristics, because of their affects on incoming and outgoing radiation; however, overall emissions and resulting impacts on temperature would be insignificant.

Although aerosols produced by possible increased refinery activity in Billings and Great Falls could affect precipitation patterns through increased cloud condensation nuclei formation, any resultant changes in precipitation would probably be minor.

Climatic impacts may occur during the operational phase. During periods of extreme cold, additional stress may be put on people, materials, and machinery needed for pipeline operation. High winds or icing may topple powerlines, resulting in a curtailment of operations. Heavy thunderstorms may contribute to a break in the pipeline by flash flooding at stream crossings; mudslides could damage the line if the pipeline were not properly constructed and sited.

Impacts on Air Quality

No major air quality impacts are expected to result from the Northern Tier Pipeline in Montana; however, localized minor impacts may be noted during construction and operation. Construction of the pipeline, pump stations, and delivery facilities would result in temporary emissions from equipment and in fugitive dust generation. Opera-

tion of the system may result in some hydrocarbons and other emissions from surge and storage tanks at pump stations and delivery facilities, and from diesel back-up generators. A secondary impact associated with the pipeline operation could be a possible increase in refinery production, with possible subsequent deterioration of air quality.

In areas of poor dispersion potential and rugged terrain, relatively minor emissions may cause air quality problems; however, the same emissions might cause minimal problems in areas of good dispersion potential and open terrain. In western Montana, the dispersion potential is poor, and there may be problems with pollutant buildup during construction—particularly in valleys with frequent temperature inversions. In central and eastern Montana, higher wind speeds and less frequent inversions would disperse pollutants more easily.

Pipeline Construction

Numerous air pollutants would be produced during pipeline construction. Several pollutants, including nitrogen oxides, carbon monoxide, sulfur oxides, and particulates would be emitted by construction equipment. Increased fugitive dust levels also would occur along the pipeline route. Openburning of debris (which would have to be permitted by DHES) could increase air pollutant levels. Electromagnetic interferences in the immediate area may result from equipment ignition systems and other electrical apparatus.

TABLE 37. POLLUTANT EMISSIONS FROM PIPELINE CONSTRUCTION

POLLUTANT	EMISSION RATE[1] (lb/working day)
Nitrogen oxides	4,400
Carbon monoxide	1,400
Hydrocarbons	310
Sulfur dioxide	290
Particulates	190
Fugitive dust	7,700-11,000

SOURCE USDI 1979
CONVERSION FACTOR 1 lb = 4536 kg
[1] Based on a 6 to 12 km (4 to 8 mi-long) open trench on a 12 to 24 km (8-to 16-mi) construction spread, for two to four weeks

Table 37 estimates pollutant emissions from pipeline construction. According to studies conducted on the Alaska Natural Gas Pipeline, dust emissions from pipeline construction are roughly equivalent to emissions from highway construction. Based on this assumption, an estimated dust emission rate of five tons per pipeline mile was derived. This agrees with the fugitive dust value shown in table 37 based on one pipeline mile per working day.

Debris from clearing the right-of-way (e.g., trees, brush) could be disposed of by opening burning. Low flame temperatures associated with open burning produce particulates, carbon monoxide, and hydrocarbons, as well as small amounts of nitrogen oxides and sulfur oxides. Temporary degradation of air quality and annoyance of nearby residents may result from this burning. However, open burning would probably be limited to nonurban areas and should affect relatively few people.

Construction camps could be another source of air pollution from fuel burning. If nearby towns or cities absorb short-term population increases associated with construction, minor increases in an area emission sources are possible. These effects are short-lived and should not cause any serious deterioration of air quality.

TABLE 38. POLLUTANT EMISSIONS FROM CONSTRUCTION OF A TYPICAL PUMP STATION

POLLUTANT	EMISSION RATE (lb/working day)
Nitrogen oxides	660
Carbon monoxide	160
Hydrocarbons	46
Sulfur dioxide	46
Particulates	27
Fugitive dust	500

SOURCE USDI 1979
CONVERSION FACTOR 1 lb = 4536 kg

Construction of Pump Stations and Delivery Facilities

Air pollutants generated during pump station and delivery facility construction should be similar to those from pipeline construction. Emissions from pump station construction based on EPA emission factors are given in table 38. Disturbance of 2 ha (5 acres) per site would result in some fugitive dust emissions until the area is reclaimed. Impacts would be localized, depending on soil and meteorological conditions.

Delivery facilities would be constructed at intersections with the Glacier and Western Crude Oil Pipelines in Montana. Estimated quantities of pollutants generated during the construction of the facilities are shown in table 39.

Pipeline Operation

Crude oil pipelines have little impact on air quality during normal operations; however, accidents, such as spills or fires, could cause significant emissions. The impacts of these emissions would vary with location.

Seven pump stations are scheduled for installation on NTPC's proposed route

TABLE 39. SUMMARY OF CONSTRUCTION EMISSIONS FOR DELIVERY FACILITY

POLLUTANT	EMISSION RATE (lbs/working day)
Nitrogen Oxides	1140
Carbon Monoxide	280
Hydrocarbons	80
Sulfur Dioxide	75
Particulates	55
Fugitive Dust	3300
Fugitive Hydrocarbons	600

SOURCE USDI 1979
CONVERSION FACTOR 1 lb = 4536 kg

through Montana. Since they would be powered by electrical motors, there would probably be no emissions. The backup diesel-powered generators would emit minor amounts of pollutants when operating (see table 40, p. 94). Electromagnetic interferences with radio and television reception may be caused by the electrically driven pipeline facilities and associated high-voltage powerlines.

There may be hydrocarbon emissions from surge tanks, which are proposed to have floating roofs, as well as from fixtures in the pump stations such as valves and pump seals. Hydrocarbon emissions near the proposed facilities should not exceed federal guidelines and most likely would be minor, although delivery facilities may release hydrocarbons from storage tanks. Table 41, p. 94., lists estimated emissions from the proposed Montana delivery stations. During normal operation, the pipeline is not expected to violate PSD standards.

Oil Spills

If an oil spill occurs, posing an immediate threat such as entering a waterway, DHES may issue a permit for open burning of the oil. The impacts associated with this would depend on: (1) the sulfur content of the oil, (2) the amount of burning required, which would be determined by the surface area, and (3) present meteorological conditions.

The general impacts would be sulfur oxide emissions; particulates, such as partially burned hydrocarbons, and dense, black smoke. Further impacts could not be determined without detailed information on the chemical constituents of the oil. The impacts would probably be short-term.

MEPA Concerns

The overall potential impact of the pipeline on Montana's climate and air quality would probably be insignificant. The air environment is essentially a renewable resource when not subjected to continuous pollution; therefore, no irreversible or irretrievable commitments of air quality or climate along the pipeline route would be anticipated.

TABLE 40. DIESEL BACK-UP GENERATOR EMISSIONS

Pollutant	Emission Factor (lb/1000 gal)[1]	EMISSION RATE[2] lb/hr.	EMISSION RATE[2] lb/week
Carbon Monoxide	102	0.816	0.816
Exhaust Hydrocarbons	37.5	0.300	0.300
Nitrogen Oxides	469	3.75	3.75
Aldehydes	7.04	0.056	0.056
Sulfur Oxides	31.2	0.250	0.250
Particulates	33.5	0.270	0.270

CONVERSION 1 lb = 4536 kg
1,000 gal = 3 785 L

[1] Emission factors are from USEPA 1976

[2] Emission rates are based upon 8 gallons fuel consumption per hour and 1 hour operation time per week (for lubrication purposes)

TABLE 41. HYDROCARBON EMISSIONS FROM DELIVERY FACILITIES

TRANSFER FACILITY	ANNUAL EMISSION RATE (Tons/Year)	WORST-CASE EMISSION RATE (lb/hr)
Glacier	25.4	9.4
Western Crude	18.3	7.2

SOURCE USDI 1979
CONVERSIONS 1 ton = 9072 tonne
1 lb = 4536 kg

Construction emissions, such as heavy equipment exhaust and fugitive dust, could have short-term impacts on air quality in a localized area. The degree of impact would be strongly influenced by the local atmospheric dispersion potential. Accidents, such as oil spills or fires, should produce only a short-term impact on the air environment.

Potential operational (long-term) impacts include hydrocarbon emissions from pump station surge tanks and storage tanks at delivery facilities. Although minimal, emissions from maintenance vehicles and road dust would also contribute to long-term impacts. A possible increase in refinery production in Billings could have secondary long-term impacts on air quality and, to a smaller degree, on climate. However, the proposed Northern Tier Pipeline should not significantly affect the long-term preservation of the existing air quality or climate in Montana if construction, reclamation, and operation are done prudently.

Mitigating Measures

Construction Practices

The following measures would mitigate adverse impacts on air and climate:

1) Employing proper fuel system adjustment, regular maintenance, specified fuels, and good operating practices to reduce air emissions from construction equipment.
2) Reducing fugitive dust emissions from 30 to 70 percent, depending on the extent of surface disturbances, by watering unpaved surfaces during construction activities.
3) Reducing dust generated during blasting operations by placing mats or spraying water, or water with chemical-wetting agents, over the blast area.
4) Restricting operation during extremely windy periods when excavated topsoil may be distributed.
5) Reestablishing vegetative cover on the right-of-way as soon as possible after construction to aid in reducing wind-blown dust. This is important because fugitive dust would be the most significant construction impact on air quality.
6) Limiting burning of slash and other debris to unpopulated areas and only during periods of favorable dispersion conditions.

Operation and Maintenance

Adverse impacts could be avoided by taking the following measures:

1) Using floating roofs on all tanks.
2) Using proper fuel system adjustment, regular maintenance, specified fuels, and good operating practices to reduce emissions from diesel back-up generators at pump stations.
3) Applying the best available control technology to all pipeline operations which release pollutants.
4) Responding quickly to any malfunction of equipment or operational problem to aid in reducing potential air emissions.

CHAPTER SEVEN

COMPARISON AND EVALUATION OF ALTERNATIVE ROUTES

Chapter seven includes two parts. The first presents a quantitative tabulation of impact risk along each of the routes and explains the importance of the types of impact tabulated. Included in this part, where appropriate, are explanations of the assumptions used in creating the maps that appear in chapters five and six. The methods used in gathering and analyzing the tabulated data are explained in the six Northern Tier technical reports and in other reports on file with DNRC. The second part of this chapter summarizes the effect of the routes on each of the thirteen concerns evaluated in chapter six. Detailed route descriptions and discussion of potential impacts are included in appendix G.

Mapping of potential impacts was done by designating critical and sensitive areas. Critical areas were defined as areas where a resource of county-wide, state-wide, or national importance is likely to be significantly and adversely affected even if the best available mitigating measures are employed. Sensitive areas are those (1) where a resource of county-wide, state-wide, or national importance is likely to be significantly and adversely affected if not adequately mitigated, (2) where terrain or other constraints would require costly or unconventional construction techniques or greatly increased construction time or costs, or (3) where risk of damage to the pipeline is high.

TABULATION OF IMPACT RISK

Terrain, Engineering, and Hydrologic Constraints

Constraints on pipeline design and construction are evaluated in table 42.

A weighted difficulty index based on (1) the hydrologic features of the basin upstream from each proposed crossing, (2) the estimated width of each crossing, and (3) the streambed scour potential at each crossing was devised to numerically compare the construction difficulty expected at waterway crossings. These ratings, which range from less than 1 for small streams to more than 50 for large rivers, provide a rough measure of the relative cost of construction and the relative potential environmental impacts to the streambed and vicinity during construction. Each stream crossing was then placed in one of five classes determined by its weighted difficulty index ranking. Crossings of classes 1 or 2 are minor waterway crossings with little construction difficulty; class 3 includes minor waterway crossings that may require detailed scour calculations; class 4 describes crossings of large streams or rivers, where detailed scour analyses and special construction crews and techniques would be required; class 5 includes crossings of major rivers, such as the Missouri or Clark Fork. For each route, the difficulty indices of all waterway crossings are summed in table 42.

The lengths of route segments with terrain or geotechnical constraints (such as hard bedrock, cliffs, and unstable talus or slopes) are also tabulated in table 42. These factors are collectively evaluated by a weighted index of construction difficulty, calculated per kilometer of route, in which 0 represents ideal construction conditions and 100 represents extremely difficult construction conditions.

Accurate cost projections cannot be calculated because the routes have not been surveyed and final designs have not yet been done. However, costs relative to the engineering difficulties of the routes are discussed later in this chapter.

Earthquake Hazards

The earthquake hazards of the alternative routes, although not tabulated in table 42, are discussed later in this chapter. In the mountainous western part of Montana, there are a number of young faults and several broad seismically active areas. Measures to further identify and reduce seismic risk are discussed more fully in chapter five. All faults and areas described in chapters five and seven are shown on map 3, p. 44.

Geologic Concerns and Mineral Resources

The evaluation of geologic concerns and mineral resources in chapter six identified slope failure and cliff complexes as critical hazards along the pipeline routes. The length of route segments with these potential problems is tabulated in table 42, under the heading "Terrain, Engineering, and Hydrologic Constraints." The investigation also provided data on lignite fields, rock areas, and steep slopes, all of which affect pipeline construction difficulty and cost but are not considered hazards. The geologic concerns important to pipeline design and construction appear on map 4, p. 48, along with other engineering concerns.

The engineering comparison of routes depends to a considerable extent on geologic conditions, and there is therefore some unavoidable overlap in treating geologic and engineering concerns.

Land Use

In the comparison of routes, there are four areas of concern with regard to land use: legal constraints, specially managed areas, site patterns, and linear patterns. These are discussed below, with reference to table 42 and 43. The distinctions between the four areas are not always clear. Specially managed areas, for instance, are site patterns and can also be considered as legal constraints.

Another consideration that would be of interest in the comparison of routes is the compatibility of the proposed pipeline with existing linear land use corridors—in other words, the potential for constructing the pipeline along existing corridors rather than

TABLE 42. IMPACT RISK ALONG NTPC'S PROPOSED ROUTE AND DNRC'S ALTERNATIVE ROUTES

	ROUTES WEST OF BONNER				ROUTES EAST OF BONNER				
	Northern Tier Proposed Route	DNRC Modification Route	Arlee Route	Knox Pass Route	Northern Tier Proposed Route	DNRC Modification Route	Hi-Line Route	Raynesford Route	St. Ignatius Route
Total length of route (km)	177	178	185	188	827	835	821	816	1,020
TERRAIN, ENGINEERING, AND HYDROLOGIC CONSTRAINTS									
No. of crossings of waterway class[1] 1-2	56	52	55	52	163	163	104	152	194
3	0	0	0	1	49	54	54	64	55
4	1	1	1	0	7	7	16	9	9
5	3	3	4	3	6	7	5	5	10
Difficulty index of waterway crossings 1-2	62	57	60	57	225	224	166	226	262
3	0	0	0	5	245	270	270	320	275
4	18	18	18	0	126	126	288	162	162
5	313	313	427	203	379	392	226	329	856
TOTAL	393	388	505	265	975	1,012	950	1,037	1,555
Km of rock ditching requiring drilling and blasting	9	11	18	22	50	43	7	5	34
Km of rock ditching requiring heavy ditching equipment but not blasting	20	23	52	34	66	87	109	77	139
Km of cliff and talus area	18	24	<1	7	3	3	3	3	<1
Km of potential slope failure	0.5	1.4	0.8	0.8	0.0	0.0	0.0	0.0	0.0
Route construction difficulty index[2] (per km)	56	52	51	51	46	46	45	47	47
LAND USE—SITE PATTERNS									
Urban (km crossed)	0	<1	<1	5	1	1	2	<1	1
Suburban and rural residential (km crossed)	2	0	<1	3	10	10	1	1	10
Industrial (km crossed)	<1	1	<1	<1	0	0	<1	0	0
Oilfields (km crossed)	2	0	2	0	0	0	0	0	2
Recreational (names of sites crossed				Alberton	Helena fair-grounds	Helena fair-grounds			Helena fair-grounds
Rangeland[3] (km crossed)	48	37	84	28	551	570	371	512	631
Dry cropland (km crossed)	2	7	8	14	131	140	307	186	135
Irrigated cropland (km crossed)	12	11	15	2	36	36	33	9	56
LAND USE—LINEAR PATTERNS									
Paved roads									
No. of crossings	8	6	7	11	17	22	25	25	28
Length of route within 5 km of paved roads (km)	16	35	9	93	50	152	100	145	36
Length of route further than 5 km from any paved roads (km)	6	6	6	6	18	18	16	3	31
Unpaved roads									
No. of crossings	80	93	77	75	142	158	275	209	217
Length of route within .5 km of unpaved roads (km)	87	79	18	27	137	89	166	136	187
Powerlines									
No. of crossings	31	35	39	21	16	20	20	13	59
Length of route within .5 km of powerlines (km)	38	55	79	84	40	67	138	56	106
Pipelines									
No. of crossings	7	5	7	4	7	14	10	10	10
Length of route within 5 km of pipelines (km)	20	17	96	6	3	68	14	3	16
Railroads									
No. of crossings	4	5	6	7	9	17	5	8	10
Length of route within 5 km of railroads (km)	7	22	2	70	31	34	26	6	33

	ROUTES WEST OF BONNER				ROUTES EAST OF BONNER				
	Northern Tier Proposed Route	DNRC Modification Route	Arlee Route	Knox Pass Route	Northern Tier Proposed Route	DNRC Modification Route	Hi-Line Route	Raynesford Route	St. Ignatius Route
AQUATIC LIFE AND HABITATS									
No. of stream crossings	80	73	65	81	174	168	156	169	211
No. of stream crossings of DFWP class[1] 1	0	0	0	0	3	3	0	1	2
2	2	2	1	4	0	2	1	2	3
3	4	4	6	10	3	6	14	14	12
4	22	19	8	10	17	17	12	6	31
5+6	52	48	50	57	151	140	129	146	163
No. of stream crossings for which highest value stream reach within 10 km downstream is DFWP class[1] 1	0	0	0	0	24	18	23	25	6
2	31	31	5	39	5	28	15	14	15
3	32	26	35	20	43	38	63	63	84
4	13	12	13	18	34	19	22	16	38
5+6	4	4	12	4	68	65	33	51	68
No. of perennial streams crossed more than twice	3	3	2	5	3	4	2	2	4
No. of crossings of streams with a mean flow volume of									
<100 ft^3/s	72	67	58	76	170	159	148	159	197
100-500 ft^3/s	4	2	2	2	1	4	5	7	7
500-3,000 ft^3/s	1	1	1	0	1	3	3	1	1
3,000-10,000 ft^3/s	1	1	0	3	1	1	0	1	1
>10,000 ft^3/s	2	2	4	0	1	1	0	1	5
No. of stream crossings for which the highest mean flow volume within 10 km downstream is									
<100 ft^3/s	10	10	12	7	129	106	79	98	129
100-500 ft^3/s	18	18	18	26	14	12	34	27	45
500-3,000 ft^3/s	1	0	1	0	22	41	38	38	11
3,000-10,000 ft^3/s	21	19	5	42	8	8	5	5	4
>10,000 ft^3/s	30	26	29	6	1	1	0	1	22
No. of crossings of streams with DHES ratings of A	1	1	1	1	0	0	0	0	0
$B\text{-}D_1$	79	72	64	80	117	98	95	113	141
$B\text{-}D_2$	0	0	0	0	19	19	14	6	19
$B\text{-}D_3$	0	0	0	0	38	51	47	50	51
No. of crossings of streams with									
low (<1%) gradient	8	6	7	8	15[4]	21[4]	17[4]	17[4]	31[4]
medium (1-8%) gradient	55	47	56	46	55	54	52	52	81
high (>8%) gradient	17	20	2	27	21	15	22	22	11
Km of route paralleling a stream within 225 m	55	46	34	86	22	33	36	36	39
Km of route paralleling within 225 m a stream of DFWP class[5] 1	0	0	0	0	15	15	15	15	0
2	4	4	0	23	0	0	0	0	0
3	16	7	7	14	0	0	9	9	4
4	35	35	27	25	5	5	5	5	35
5+6	0	0	0	24	2	13	7	7	0

TOTAL amount of linear land use corridors within .5 km of route, as tabulated above[4] (km)	168	208	202	279	261	411	444	347	379
TOTAL length of route within .5 km of other linear land use corridors (km)	121	129	152	128	189	303	286	276	267
Irrigation ditches:									
No. of crossings	2	0	0	0	15	15	0	1	16
SOCIAL AND ECONOMIC CONCERNS									
Lodging shortfall (person-nights)	1,687	1,687	870	870	133,750	131,263	53,941	108,697	167,515
Lost land productivity (dollars)									
Temporary	14,800	15,500	22,200	17,900	163,500	178,600	221,500	178,800	187,200
Permanent	236,400	236,500	153,000	259,000	148,200	112,800	152,300	138,400	275,000
Montana employment									
Construction (person-years)	89	89	98	89	292	292	286	283	381
Permanent (jobs)	0	0	0	0	57	57	57	57	57
Property tax revenues (million dollars)	41-79	42-82	45-94	67-131	128-250	130-253	176-361	174-338	164-320
VISUAL QUALITY									
Potential visual impact km of: high	102	93	103	103	82	100	84	97	186
medium	0	0	0	5	64	83	18	11	61
low	75	85	82	80	681	652	717	708	773
SOILS									
Soil erosion potential km of: high	111	113	99	114	163	181	88	172	239
medium	61	61	61	63	288	208	169	190	328
low	5	4	25	11	376	446	564	454	453

CONVERSIONS 1 km = .622 mi
.02832 m^3/s = 1 ft^3/s

[1] 1 is least difficult 5 is most
[2] 0 = ideal conditions, 100 = extreme difficulty
[3] Corresponds to the deciduous coulee sagebrush grassland and wetlands categories in the Vegetation and Land Productivity section of this table below
[4] When the total amount of linear land use corridors is more than the total length of the route it results from the paralleling of two existing corridors simultaneously. The line following total length of route within .5 km of other linear land use corridors shows how much of each route is within .5 km of one or more existing land use corridors. In every case this number is less than the total length of the route indicating that new corridor would have to be established along every route
[5] 1 denotes highest-value fishery 5 lowest value 6 denotes unclassified fisheries
[6] The numbers of stream crossings tabulated here for the routes east of Bonner and for the St. Ignatius Route are less than the total numbers of crossings given above because gradient was not considered an important factor in eastern Montana thus the gradient of stream crossings on the eastern portion of each route was not calculated
[7] 5 denotes highest impact risk and 1 lowest
[8] Because of the mapping scale used and the methods used for measuring these many small areas of land cover the distances shown for the land cover categories for each route may not add to the routes total length as given above
[9] The recent clearcut categories were omitted from this total because they would not have to be cleared if the right of way were to cross them
[10] Corresponds to the urban, suburban and rural residential industrial, and oil fields categories in the Land Use—Site Patterns section of this table above
[11] WR = winter range CSW = concentration area during severe winters

Km of route paralleling within 225 m a stream for which the highest-value stream reach within 10 km downstream is DFWP class[5]: 1	0	0	0	0	17	15	15	15	0
2	20	19	0	33	0	13	9	9	0
3	21	12	19	30	0	0	12	12	19
4	15	15	15	22	5	5	0	0	20
5+6	0	0	0	0	0	0	0	0	0
GROUND WATER									
Km of risk category[7]: 5	29	12	16	24	27	30	19	24	44
4	88	81	78	80	86	108	80	81	230
3	0	0	0	0	85	81	150	67	85
2+1	60	85	91	84	629	616	572	644	661
No. of wells within 300 m of route	126	100	118	239	134	276	588	456	237
Towns using ground water for part or all of public water supply	Missoula Bonner	Missoula Bonner	Missoula Bonner	St Regis Alberton Missoula Bonner	Helena Martinsdale	Avon Elliston Helena Martinsdale Circle Richey	Ovando Lincoln Carter Chinook Zurich	Ovando Lincoln Denton Circle	St Ignatius Martinsdale
VEGETATION AND LAND PRODUCTIVITY[8]									
Km of each type crossed:									
Red cedar-hemlock forest	6	5	0	0	0	0	0	0	0
Grand fir forest	20	16	14	34	0	0	0	0	14
Subalpine fir forest	0	0	0	6	2	2	1	1	2
Douglas fir forest	89	109	77	84	82	64	68	68	132
Ponderosa pine forest	0	1	0	0	0	0	0	0	0
Grand fir recent clearcuts	1	1	1	1	1	1	0	0	3
Douglas fir recent clearcuts	6	5	11	27	2	1	0	0	6
Unclassified coniferous forest	0	0	0	0	0	0	13	13	73
Total coniferous forest[9]	115	131	91	124	84	66	82	82	221
Cottonwood forest	0	0	0	0	<1	<1	4	6	<1
Deciduous coulee	0	0	0	0	0	0	3	2	0
Sagebrush-grassland	48	37	84	28	550	570	368	510	630
Wetland	0	0	0	0	<1	0	0	0	<1
Irrigated cropland	12	11	15	2	36	36	33	9	56
Dry cropland	2	7	8	14	131	140	307	186	135
Other[10]	5	1	3	8	11	11	3	2	13
Scree	<1	10	<1	<1	0	0	0	0	<1
WILDLIFE AND HABITATS									
Km of each type crossed:									
Total waterfowl habitat	20	14	9	4	13	129	401	5	134
"Excellent" waterfowl habitat	0	0	0	0	11	11	67	3	11
Mountain grouse habitat	169	161	77	110	142	121	138	157	208
Total sage grouse habitat	0	0	0	0	457	459	152	470	457
"Excellent" sage grouse habitat	0	0	0	0	164	158	25	202	164
Total sharp-tailed grouse habitat	0	0	0	0	667	652	526	701	706
"Excellent" sharp-tailed grouse habitat	0	0	0	0	177	196	250	355	177
Ring-neck pheasant habitat	29	30	7	18	54	70	145	211	57
Gray partridge habitat	34	33	17	25	655	666	650	675	684
Turkey habitat	19	19	24	0	0	1	19	0	22
Elk WR[11]	105	85	40	51	27	25	26	26	6
Elk CSW[11]	6	4	<1	3	0	0	1	1	<1
Mule deer WR	86	66	64	57	337	347	138	519	405
Mule deer CSW	7	4	1	2	39	35	29	25	72
White-tailed deer WR	148	130	85	72	84	123	124	317	143
White-tailed deer CSW	21	20	0	10	3	3	14	7	13
Moose WR	0	0	11	0	3	40	10	10	75
Pronghorn WR	0	0	13	0	352	372	60	322	352
Pronghorn CSW	0	0	0	0	18	11	18	32	18
Bighorn sheep WR	4	16	4	0	0	0	0	0	4
AIR QUALITY									
Quality	good	good	fair	good	good	good	good	good	fair
Dispersion potential	fair	fair	poor	poor	fair	fair	fair	fair	poor

establishing new ones. This is not shown directly in table 42, although a rough measure may be found under "Land Use—Linear Patterns" in that table as the distance of each of the routes paralleling another corridor within 0.5 km (0.3 mi). However, because pipeline construction may not be compatible with the existing uses of some corridors, new corridors may still have to be established even where the proposed pipeline would closely parallel existing corridors. Therefore, the "0.5 km" measurements cannot be considered accurate measurements of the amounts of existing corridor which could be used by NTPC, and no more accurate measurements are possible until a route and centerline have been chosen and a final design study prepared. The compatibiltiy of the proposed pipeline right-of-way with existing corridors will be considered at that time, since the sharing of a single corridor by two or more linear users is an effective way of mitigating impact.

Legal Constraints

The legal constraints on pipelines (such as zoning or the presence of specially managed areas through which pipelines are prohibited) along each of the routes are not listed in table 42 but are discussed in the second part of this chapter. Such constraints can prevent pipelines through some areas, requiring changes in routing.

Specially Managed Areas

The federal, state, local, and private specially managed areas shown in tables 42 and 43 are those that would be crossed by one or more of the routes. Many of these areas presently prohibit pipeline crossings (see tables 28 and 29 on pp. 56 and 57), but this restriction may soon be lifted from some of them. The BLM wilderness study areas are an example; because they are currently managed as wilderness, pipeline crossings are prohibited unless permitted by Congressional action or an executive order of the President. As soon as the wilderness studies have been completed, pipeline crossings may be allowed across those areas not recommended for wilderness designation. In the case of the Forest Service-administered RARE II roadless areas which were not recommended for wilderness study, management plans are to be prepared before the areas are allocated to particular uses.

The proposed pipeline could affect even those specially managed areas it doesn't cross; if it were constructed adjacent to such an area, impacts such as sedimentation or oil spills could occur within the specially managed area.

Site Patterns

The land-use site patterns considered separately in table 42 are urban (more than one structure per acre), suburban and rural residential (less than one structure per acre but at least one structure for every twenty acres), industrial (including oil fields), recreational, and agricultural (several categories of agricultural land are shown). The recreational sites shown in table 42 may be avoided through judicious centerline selection.

Linear Patterns

The linear land-use patterns assessed in relation to the routes in table 42 are paved roads, unpaved roads, powerlines, pipelines, railroads, and irrigation ditches. For all routes, the length of that portion of the route that is further than 5 km (3 mi) from any paved road was tabulated because that measurement indicates: (1) the amount of new access road that may be needed and (2) the remoteness of the routes. Both of those considerations are important, for instance, in evaluating the potential effects of the proposed pipeline on wildlife. The amount of each route within 0.5 km (0.3 mi) of an existing linear land-use corridor was also tabulated as an indication of the extent to which the pipeline might share existing corridors.

The number of crossings of linear land uses (regardless of type) tabulated in table 42 indicates construction difficulty and possible impacts to those other uses.

TABLE 43. CROSSINGS OF SPECIALLY MANAGED AREAS BY NTPC's PROPOSED ROUTE AND DNRC's ALTERNATIVE ROUTES

ROUTES EAST OF BONNER

Northern Tier Proposed Route		DNRC Modification Route		Hi-Line Route		Raynesford Route	
Area	Km Crossed	Area	Km Crossed	Area	Km Crossed	Area	Km Crossed
Canyon Ferry Wildlife Management Area	2	Canyon Ferry Wildlife Management Area	2	Clearwater Game Range	5	Clearwater Game Range	5
				Nature Conservancy Easement	[1]	Nature Conservancy Easement	[1]
				BLM East Lonesome Lake Wilderness Study Area (260)	8	BLM Cat Creek Wilderness Study Area (220)	1
				BLM Black Coulee Wilderness Study Area (303)[2]	8		
				BLM Garland Creek Wilderness Study Area (306)	5		
				BLM Rock Creek Wilderness Study Area (355)	5		
				BLM Bitter Creek Wilderness Study Area (356)[2]	11		

ROUTES WEST OF BONNER

Northern Tier Proposed Route		DNRC Modification Route		Arlee Route		Knox Pass Route		St. Ignatius Route	
Area	Km Crossed	Area	Km Crossed	Area	Km Crossed	Area	Km Crossed	Area	Km Crossed
RARE II Patrick's Knob North Cutoff (1-794)	3	RARE II Patrick's Knob North Cutoff (1-794)	3	RARE II Patrick's Knob North Cutoff (1-794)	3	RARE II Cherry Peak (1-791)	2	RARE II Patrick's Knob North Cutoff (1 794)	3
RARE II North (1-796) Siegel	9	RARE II North (1-796) Siegel	9			Alberton Water Supply	1	South Fork of the Jocko Sacred Area	12
								Clearwater Game Range	6

NOTE These specially managed areas are shown on map 5, p. 58

[1] Point crossing

[2] Recommended for intensive inventory

Social and Economic Concerns

A rigorous socioeconomic impact assessment of a major resource development project typically attempts to predict what social and economic difference the project would make. This requires forecasting social and economic conditions with and without the project and measuring the difference, at given points in time, between them. This methodology has not been adopted in the impact assessment of the Northern Tier Pipeline because:

1) No significant unmitigatable social impacts are anticipated
2) The principal direct impacts on the economy, public services and facilities, and lodging occur during the construction period and are highly transient
3) Almost no lasting induced/secondary employment effects are anticipated from project construction, due to its short-term nature

Instead, this assessment employed an incremental analysis that attempts to establish the baseline (1979) values of key parameters, assumes they will apply in 1980 as well, and estimates the impact of the project on them. These steps were included: (1) determining the number, location, and duration of residence in a given location of nonlocal pipeline workers; (2) converting that information into demands for lodging, food, public services, and commercial services; (3) comparing these demands with the supply of such facilities and services within commuting distance to the pipeline; and (4) analyzing the degree to which imbalances of demand over supply exist. In addition, income, employment, and fiscal effects from the project were estimated.

The four social and economic concerns tabulated in table 42 are listed and defined below:

1) Lodging shortfall—an estimate of the difference between the number of person-nights of lodging (motels, camp sites, and recreational vehicle hookups) expected to be needed by nonlocal pipeline workers and the number expected to be available in the absence of mitigation.
2) Lost land productivity—an estimate of the monetary value of lost production, both short- and long-term, from land crossed by the pipeline. For example, with cropland, one season's productivity would be lost for the area of the construction right-of-way; in forest land that must be cleared, nonmerchantable timber would be lost during initial clearing, and timber production would be eliminated for the life of the pipeline.
3) Montana employment—two measures of Montana employment are provided: (1) construction (defined as the amount of temporary employment that would go to Montanans, measured in person-years) and (2) permanent (defined as the number of permanent jobs, both direct and indirect, that would be filled initially by residents of Montana).
4) Property tax revenues—two estimates of the amount of property tax NTPC would pay over the projected twenty-year life of the project. The lower estimate is based on an appraisal value of the line that depreciates to salvage value at the end of the twenty-year period. The higher estimate is based on a constant appraisal value; both assume no change in property tax rates or assessment ratios.

Cultural Resources

The historic and prehistoric sites that provided the data for the cultural resources study were identified from the following three sources: (1) the latest edition of the **National Register of Historic Places** (Feb. 7, 1978), (2) maps and preliminary tables used by the BLM for its Northern Tier draft EIS (USDI 1979), and (3) site forms on file at the University of Montana. All recorded sites with legal descriptions within the study corridors were mapped at a scale of 1:125,000.

The accuracy of some of these data is questionable. In many cases, the legal descriptions identify a site only as within a particular quarter of a quarter section (16 ha, or 40 acres). Until an intensive inventory of cultural sites is completed for a centerline, the number and significance of sites involved will not be known. Therefore, cultural resources are not tabulated in table 42.

Visual Quality

Table 42 shows the length of each route subject to low, medium, or high potential visual impact from the proposed pipeline. The criteria used in assigning these impact risk ratings are listed in table 44.

Visual Quality Mapping Assumptions

On map 5, p. 58, areas of medium potential visual impact are interpreted as "sensitive," and areas of high potential impact as "critical." In this regard, "sensitive" visual resources are those of county, state, or national importance that would be significantly and adversely affected if not adequately mitigated. Generally, this classification describes forests without high visual quality—for instance, those that are heavily roaded or that are interspersed with clear-cuts or grasslands. For these areas, mitigation by minor centerline adjustments or the planting of screening shrubs may be feasible. "Critical" describes a visual resource of county, state, or national importance that would be significantly and adversely affected even if the best mitigating measures are used. These are usually forests where clearing the right-of-way would create a conspicuous strip of deforested land.

Soils

Because soils have not been mapped uniformly statewide, the erosion potential along the routes was evaluated according to average annual precipitation, average length of frost-free season, slope, and parent material of the soil. The amount of low, medium, and high erosion potential along each route is shown in table 42.

TABLE 44. POTENTIAL VISUAL IMPACT RATING CRITERIA

	POTENTIAL VISUAL IMPACT		
	Low	Medium	High
Amount of Forest	Nonforested	Sparsely forested	Densely forested
Scenic Quality	Low (monotonous or industrialized land)	Moderate (typical views)	High (high visual contrasts; unusual or unique visual resources)
Water Bodies	None	Some	Many
Intensity of View[1]	Roads through these areas traveled by an average of 20 or fewer vehicles per day	Roads through these areas traveled by an average of between 20 and 200 vehicles per day	Roads through these areas traveled by an average of more than 200 vehicles per day; or they receive over 200,000 vistor-days per year
Use Association	A minor consideration in these areas	A secondary consideration in these areas	Recreational areas, historical tourist areas
Community Relationships	Community considers visual resources unimportant	Community considers visual resources moderately important	Community demands that visual resources not be disturbed
Agency Use and Planning Attitudes[2]	These areas not managed to control visual impacts	These areas managed with some consideration given to visual impacts	These areas primarily managed to minimize visual impacts

[1] U.S. Highway Department standards.
[2] This reflects the general attitudes and visual management practices of the Bureau of Land Management, Department of Agriculture, Forest Service, and other agencies associated with the area.

Soil erosion caused by new access roads and powerline rights-of-way is not evaluated in detail. Such erosion would be almost directly proportional to the amount of mountainous terrain and number of nearby roads and powerlines.

Soils Mapping Assumptions

On map 4, p. 48, route segments with high erosion potential are identified. Segments with low or medium erosion potential are not shown because most of such impacts can be avoided or sharply reduced through the use of proper erosion control and reclamation methods.

Aquatic Life and Habitats

The criteria used to evaluate the effects on aquatic life and habitats of constructing the proposed pipeline are explained below and tabulated in table 42. No new data were gathered for this study, and the available data were limited. Available information, on aquatic invertebrates and plants for example, is spotty and not standardized and does not lend itself to route comparisons across the entire state. Information on the status of fish across the state, on the other hand, is readily available. Because fish are at the top of the food chain in aquatic systems, they are a good indicator of the quality of aquatic habitat and of what other types of organisms exist in a section of stream. For these reasons, the potential effects of the pipeline on aquatic life and habitats were evaluated in terms of its effects on fisheries.

Judging the relative quality of fisheries requires consideration of fish productivity and spawning, species present, use for fishing, and aesthetics, among other things. The Montana Department of Fish, Wildlife, and Parks (DFWP) has developed a fisheries classification system that evaluates the existing data on Montana streams according to these considerations. This system (shown on table 45) was used as one of the criteria for comparing the potential impacts on aquatic life and habitats of the routes. DFWP has also identified species of special concern in Montana because of limited gene pools and habitats; these species are considered in the ranking of streams according to the system shown on table 45 and are mentioned where relevant later in appendix G.

The four main types of information tabulated in table 42, and the reasons for tabulating them, are as follows:

1) The class (according to the system shown in table 45) of each stream crossed by one or more of the routes. These classifications provide a way to evaluate the relative value of the affected fisheries.
2) The class and length of each stream paralleled by a route within 225 m (740 ft). The potential for impact to a stream from sedimentation or oil spills would be higher where the pipeline closely parallels the stream.
3) The class of the highest-class stream reach within 10 km (6 mi) downstream from a stream crossing of a route or from a stretch of stream paralleled within 225 m (740 ft) by a route. Oil will be transported downstream from a spill; also, the cumulative sediment generated by crossing many small tributaries could affect the major drainage.
4) Multiple crossings of the same stream. Multiple crossings would result in more severe impacts to a stream than would a single crossing.

TABLE 45. THE STREAM CLASSIFICATION SYSTEM OF THE MONTANA DEPARTMENT OF FISH, WILDLIFE AND PARKS

CLASS	DESCRIPTION
1	Highest-value fishery
2	High-priority fishery
3	Substantial fishery
4	Limited fishery
5	Low-value fishery
6	Not classified

NOTE A description of the criteria used in assigning streams to these classes is available from DFWP

Flow volumes and gradients of affected streams were also determined for each of the affected routes and are included in table 42. Flow volume is of use in evaluating potential impacts because crossings of large streams generally require more streambed and bank excavation and more instream construction activity of longer duration than do crossings of smaller streams. Larger streams would also generally transport an oil spill over a greater area than would smaller streams. However, because smaller streams have less capacity to dilute oil and flush out sediments than larger streams, the relative impact to smaller streams could be greater than to larger streams. Stream gradients figured in the comparison of routes because oil spills in fast-flowing mountain streams would be difficult to contain and because lower-gradient streams would be less able to flush out sediments than would higher-gradient streams. Gradients were considered only in western Montana, where terrain is much more varied than in eastern Montana.

Water quality is another important consideration for aquatic life and habitats. The water quality classification system developed by the Montana Department of Health and Environmental Sciences (DHES) was used in this study to describe water quality. Classification types range from highest quality (A) for water suitable for a municipal water supply, to lowest (E, F) reflecting prior pollution from large industries and suitable only for industrial or agricultural purposes. The water classes along the alternative routes, tabulated in table 42, were all within the B classification: $B\text{-}D_1$, $B\text{-}D_2$, and $B\text{-}D_3$. The DHES description of class B water is as follows:

> The quality is to be maintained suitable for drinking, culinary and food processing purposes after adequate treatment equal to coagulation, sedimentation, filtration, disinfection and any additional treatment necessary to remove naturally present impurities; bathing, swimming and recreation; . . . and agricultural and industrial water supply.

The $B\text{-}D_1$ class differs from the $B\text{-}D_3$ class only in that the former is to be maintained for growth and propagation of salmonid fishes while the latter is to be maintained only for growth and propagation of nonsalmonid fishes. The $B\text{-}D_2$ class is to be maintained for the marginal growth and propagation of salmonid fishes.

This chapter discusses the relative degree of potential impact that may be expected along the alternative routes, identifying the waterways along each route that are likely to be most affected by pipeline construction. Generally speaking, the potential for impacts to aquatic life and habitats as discussed in chapter six exists wherever a stream is crossed or closely paralleled by one of the routes. Determining the importance of particular types of impact to particular streams would require on-site investigation along the centerline. Projecting specific impacts would also require knowledge of what construction techniques and mitigating measures would be employed; at stream crossings, for instance, the amount of impact would depend on the stream crossing method used.

Aquatics Mapping Assumptions

In mapping the impacts on aquatic life and habitats (map 6, p. 70), it was assumed that, in connection with the definitions on sensitive and critical areas on p. 95:

1) All class 4 or higher fisheries are of at least county-wide importance
2) An impact must be long term (i.e., continuing for several years) to be significant
3) The best available mitigating measures, if properly implemented, could avoid all long-term impacts to aquatic communities
4) Significant impacts to aquatic resources are likely wherever a stream is crossed or closely paralleled if impacts are not adequately mitigated

Ground Water

Five categories were developed to compare ground water resources; their incidence along the routes is summarized in table 42. Risk category 5 is of greatest importance; it has shallow aquifers containing good-quality ground water heavily used for water supplies and adjacent to high-quality surface water systems. Category 4 has shallow aquifers, less than 23 m (75 ft) deep, with good-quality water. Category 3 is similar to category 4, but has poor-quality water.

Category 2 has moderately deep aquifers, 23 to 46 m (75 to 150 ft). The lowest impact risk is to category 1, which has deep aquifers that have little potential for being affected by the pipeline.

Also tabulated in table 42 are the number of wells within 300 m (1,000 ft) of the routes, since these wells could be affected by spills, and the number of towns along the routes using ground water for part or all of their public water supply.

Vegetation and Land Productivity

Table 33 in chapter six, p. 82, lists the land cover categories found within the study corridors. Not all of these are found along the particular routes selected for study; therefore, not all of the land cover categories in table 33 are tabulated in table 42. Table 42 also includes an "unclassified coniferous forest" category necessary because of inadequate mapping information along three of the routes. The "scree" and "other" land cover categories of table 42 were not considered in table 33 because their productivity is not significant. The risk of impact to vegetation from the pipeline is different for each category and was determined according to the criteria listed in table 33 and by the expected cost-effectiveness of mitigation. Tabulating the amount of each route that crosses each category (as is done in table 42) provides a means of comparing the impact risk of the routes.

The categories are discussed below in order of impact risk.

Highest Impact Risk: Coniferous and Riparian Forests

According to the analysis in chapter six, pipeline impact risk is greatest in coniferous and riparian forests, especially the most highly productive forest types (the grand fir, western red cedar, and western hemlock series), due to the long-term right-of-way effects on timber productivity. Effects on livestock forage productivity would be minor and possibly beneficial. Of the forest types listed in table 42, the ranking from highest to lowest impact risk is as follows: cedar-hemlock, grand fir, subalpine fir, Douglas fir, ponderosa pine, grand fir recent clearcuts, Douglas fir recent clearcuts, and cottonwood.

Intermediate Impact Risk: Nontimbered Rangeland

The nontimbered rangeland land cover categories shown in table 42, ranked from highest to lowest impact risk, are: deciduous coulees, sagebrush-grassland, and wetlands. The relatively low ranking of the highly productive wetland vegetation type is due to its rapid recovery rate.

Lower Impact Risk: Cropland

With proper mitigation, revegetation of both dry and irrigated cropland can be rapid, and in certain cases (e.g., fallow fields) pipeline construction would not greatly affect the following year's productivity. Since irrigated cropland is of higher productivity than dry cropland, it is rated higher in impact risk.

Lowest Impact Risk: Scree and Other Land Cover Categories

The "other" land cover category in table 42 includes urban, suburban and rural residential, and industrial (including oilfields) land. Impact risk for these land cover categories and for scree is considered negligible.

Vegetation Mapping Assumptions

In mapping the vegetation impacts (map 7, p. 80) the following assumptions were made, in connection with the definitions of sensitive and critical areas on p. 95:

1) All productive forest land, rangeland, and cropland is of at least county-wide importance
2) An impact must be long term to be significant
3) According to the impact analysis presented earlier, only forest productivity would suffer a significant (long-term) impact as a result of pipeline construction, since part of the pipeline right-of-way must be kept free of trees for the life of the project
4) The effects of pump stations and delivery facilities on any vegetation type are long term
5) The impact of pipeline construction and operation on forest productivity can be mitigated by confining all or part of the construction spread in forested areas to existing, cleared rights-of-way, such as those of large powerlines, railroads, and major roads
6) The impact of pipeline construction and operation on forest productivity cannot be completely mitigated where new rights-of-way must be created through forested areas, and the impact of pump stations on vegetation productivity cannot be mitigated in any vegetation type
7) Pump station and delivery facility locations were assumed to be as shown on map 2, p. 18, although considerable flexibility is possible in their location

Therefore, sensitive areas are those where forested land containing major existing cleared rights-of-way are crossed, and critical areas include (1) those where forest land containing no existing cleared rights-of-way are crossed, and (2) those where pump stations or delivery facility sites are to be constructed in any timber or cropland type or in the most highly productive rangelands (those having a rating of 10 for livestock forage productivity in table 33).

Wildlife and Habitats

Table 42 includes a tabulation of the length of each route that crosses the habitat of the wildlife species listed in table 35, p. 88. Not all of the species in table 35 appear in table 42 because some of the wildlife areas of concern, although they occurred within the study corridors, were not encountered along any of the routes and because some types of data were not available uniformly across the state. No composite wildlife impact ranking was prepared—in other words, no single ranking of the routes was determined whereby the effect of each route on wildlife in general can be compared with the effects of the other routes on wildlife in general—but the length of route crossing each category was nevertheless considered to be a measure of relative impact risk whereby the alternatives can be compared. (The distances shown in table 42 can be deceiving. A route which crosses 4 km (2.4 mi) of high-quality habitat may have a greater impact on wildlife than another which crosses 10 km (6.2 mi) of lesser-quality habitat.) Impact risk for each species and area listed is a function not only of the resource value, aesthetic value, or overall importance of the species in Montana, but also of the type and magnitude of pipeline-related impact expected as well as of the probable cost-effectiveness of mitigation.

All wildlife impacts discussed in chapter six **except** habitat loss at pump stations and delivery facilities are either short term or potentially mitigable. The likelihood of effective mitigation is not only the most important consideration in determining impact risk but also the most uncertain. It is unwise to dismiss wildlife impacts as mitigable in light of this uncertainity, yet it is perhaps unreasonable to assume that NTPC would ignore the needs of wildlife when the necessary permits were in hand. Because of this uncertainty regarding the likelihood of mitigation, DNRC did not rank the risk of impact to wildlife species in relation to the risk to other species of concern, as was done for vegetation types.

The bald eagle nest along the St. Ignatius Route west of Ovando illustrates the uncertainties involved. In the unlikely worst case, the centerline would pass directly through the nest site, construction would occur during the nesting season, and the bald eagle nest would be destroyed—a major impact. Yet if the centerline avoided the site and construction were confined to the fall and winter, the eagle would not be affected. Thus, impact risk at this site may range from negligible to major—depending on the mitigation effort applied.

Wildlife Mapping Assumptions

In mapping wildlife impact (map 8, p. 86), the following assumptions were made, in connection with the definitions of sensitive and critical areas on p. 95:

1) All wildlife species listed in table 35 are of at least county-wide importance
2) An impact must be long term to be significant
3) According to the impact analysis presented earlier, long-term impacts are most likely to result from pipeline construction through (a) severe winter concentration areas of big-game animals, (b) raptor nesting areas, (c) colonies of large water birds, (d) leks

of prairie grouse, or (e) elk summer security areas

4) Potential adverse effects of pipeline construction on wildlife species in these areas can be mitigated for all aspects of pipeline construction **except** pump stations and delivery facility sites
5) Pump station and delivery facility locations were assumed to be shown on map 2, p. 18, although considerable flexibility is possible in their locations

Therefore, sensitive areas are those listed in item 3 above where crossed by the pipeline, and critical areas are those listed in item 3 above where pump stations or delivery facilities are to be located.

Climate and Air Quality

The ratings given in table 42 for each alternative route are general ratings only for both air quality and dispersion potential. Because climate and meteorological data were not available uniformly across the state (site-specific data were common only for population centers), interpolation was necessary.

The criteria established for rating the pollution dispersion potential of the routes, selected both for data availability and for their importance to pollution dispersion, were wind speed, rainfall frequency, mixing height, and inversion frequency. Of these, wind speed was rated most heavily in the ratings because of the abundance of wind data. The boundaries of the poor, fair, and good dispersion potential areas were established by rating dispersion potential at specific locations and then interpolating the ratings between those areas. In the vicinity of the Continental Divide, topography was also considered in establishing these boundaries.

EVALUATION OF ROUTES BY CONCERN

Because no centerline has yet been selected (and won't be until a route is selected), the following discussion of impacts serves only to compare the potential impacts of the alternative routes; it cannot be considered an absolute assessment of impact risk along each of those routes because most of the impacts depend on centerline location.

Terrain, Engineering, and Hydrologic Constraints

Routes West of Bonner

In general, construction difficulty relating to soils, river crossings, wet areas, rock areas, and slope work for each of the routes west of Bonner is equal. There are small areas along each route which may present problems; these would have to be resolved by careful centerline surveying and final design.

The length and terrain variations have a direct effect on cost—more pipe, more kilometers of construction, and more required horsepower at pump stations would obviously increase costs. Although exact total amounts could not be calculated, in terms of length and required horsepower, NTPR is the most economical while the DNRC Modification Route is comparable. The Knox Pass Route is 11 km (7 mi) longer than NTPR, but would require approximately 2,000 horsepower less at ultimate capacity. However, additional river crossings and constricted areas override the slight advantage in required horsepower and make this route less desirable than NTPR. The Arlee route is ranked least desirable, because of an additional 4,000 horsepower and an increased length of approximately 8 km (5 mi) over NTPR. Although there are the least number of difficult construction areas on the Arlee Route, cost would be significantly greater than on the other routes because of the additional length and the horespower demands at pump stations.

Routes East of Bonner

NTPR, the DNRC Modification Route, and the Raynesford Route are relatively equal in construction difficulty. The Hi-Line Route encounters nine more class 4 river crossings, but has one less class 5 crossing than does NTPR. The Missouri River crossing at Townsend and those on the Raynesford Route at Great Falls and near the North Dakota border would be of equal difficulty.

A comparison of the length, pump station requirements, and terrain results in a ranking of these routes in order of preference relative to cost as (1) the Raynesford Route, (2) NTPR, (3) the Hi-Line Route, and (4) the DNRC Modification Route. However, the cost differences are small enough to be of little use in route comparison; costs would be subject to significant revision during detail design and centerline studies.

St. Ignatius Route

Considering hydrologic factors, the St. Ignatius Route is inferior to NTPR statewide and the DNRC Modification Route statewide. A combination of the Knox Pass and Hi-Line routes would result in the fewest engineering problems at waterways. The St. Ignatius Route does not significantly differ from any combination of routes in overall construction difficulty. Crossing the Jocko Pass area in the Mission Mountains east of St. Ignatius would be difficult on the west side of the pass, where the terrain is quite high and rough. However, this construction difficulty would be offset by gentle, rolling terrain on either side of the pass.

Earthquake Hazards

Routes West of Bonner

All routes closely parallel potentially active faults, but only the Arlee Route is near a fault (the Jocko Fault) with demonstrated post-Glacial (younger than ten thousand years) movement at the ground surface. Therefore, the overall seismic risk along the routes is low and roughly equal. The Arlee Route is marginally more at risk.

Routes East of Bonner

All four routes pass through approximately equal distances of seismically active areas in the mountains and are at roughly equal risk (see map 3, p. 44, and **Northern Tier Report No. 4**). The DNRC Modification Route and NTPR both cross precipitous terrain through the Garnet Range and would be perhaps at slightly more risk from earthquake-induced landslides than the Hi-Line or Raynesford routes.

St. Ignatius Route

The St. Ignatius Route has approximately the same seismic risk as any equivalent combination of alternate routes.

Geologic Concerns and Mineral Resources

Routes West of Bonner

The Arlee and Knox Pass routes each have approximately twice the length of bedrock as does either NTPR or the DNRC Modification Route. NTPR and the DNRC Modification Route have 18 and 24 km (11 and 13 mi) respectively of cliff conditions, compared to less than 1 km (0.6 mi) for the Arlee Route and 7 km (4 mi) for the Knox Pass Route. Potential landslide areas are comparable for the NTPR, Arlee, and Knox Pass routes; the DNRC Modification Route has approximately twice the potential landslide area. Rerouting during centerline survey and slope-stabilization procedures during construction could reduce this problem on the DNRC Modification Route to a negligible level.

The high amount of cliff area on NTPR and the DNRC Modification Route is generally related to slideslope construction required in the constricted canyons along the Clark Fork and its tributaries. These cliffs are stable, but considerable blasting and spoil disposal would be required.

Overall, the Arlee and Knox Pass routes are comparable, considering geologic hazards, and are slightly superior to NTPR and the DNRC Modification Route. This comparison is based on the assumption that potential hazards to the pipe (such as landslides) should be considered more important than those geologic factors that bear primarily on construction difficulty and cost (such as amount of hard rock requiring blasting).

Routes East of Bonner

The routes east of Bonner are nearly identical in construction-related geologic conditions, except for coal fields and hard rock areas. NTPR and the DNRC Modification Route cross 50 and 43 km (31 and 28 mi) respectively, of hard bedrock that would require blasting; this compares to 5 and 7 km (3 and 4 mi) respectively, for the Raynesford and Hi-Line routes. The DNRC Modification, Hi-Line, and Raynesford routes cross significant areas with strippable lignite; NTPR does not.

The DNRC Modification Route is the least desirable, the Hi-Line Route and NTPR are roughly equal, and the Raynesford Route is

clearly the best route, crossing only a short distance of hard bedrock. The Raynesford Route could avoid all lignite areas if it were to follow NTPR in McCone County.

St. Ignatius Route

Considering geologic concerns, the St. Ignatius Route is slightly better than the alternative routes. It has no known landslides or slump areas and less than 1 km (0.6 mi) of cliff area.

Electrical Service for Pump Stations

Electrical service requirements for pump stations must be examined statewide because the location and size of each station would depend on terrain and the location and horsepower of the previous pump station. Therefore, selected combinations of routes were made, and the pump stations as listed in table 46 were located. These are shown on map 2, p. 18.

TABLE 46. PUMP STATIONS FOR SELECTED ROUTE COMBINATIONS

ROUTE	PUMP STATION
NTPR Statewide	1N 2N 3N 4N 5N 6N 7N
DNRC Modification Route Statewide	1N 2N 3D 4N 5N 6N 7D
Knox Pass Route and DNRC Modification Route east of Bonner	1K 2K 2N 3D 4N 5N 6N 7D
Arlee Route and NTPR east of Bonner	1S 2A 2N 3N 4N 5N 6N 7N
NTPR west of Bonner and Hi-Line Route	1H 2H 3H 4H 5H 6H 7H 8H 9H
NTPR west of Bonner and Raynesford Route	1H 2H 3H 4R 5R 6N 7D
St. Ignatius Route	1S 2S 3S 4S 4N 5N 6N 7N

Table 47 gives estimates relating to the probable power requirements of each pump station. These estimates were derived from conversations with electric utility companies and from information supplied by NTPC.

Based upon the information provided by NTPC, it was assumed that a high priority would be placed on avoiding the construction of transmission lines supplying voltage greater than 69-kV; consequently, power would be obtained from nearby existing lines. If the nearest line with available capacity were more than 16 km (10 mi) away from the pump station and operated at a voltage above 69-kV, a substation would be built to transform the voltage carried on the new line to 69-kV.

Table 48 shows the maximum horsepower that would be used for each route, estimates of the total cost of providing electrical power to all pump stations on each route, and the estimated total new powerline corridor requirements of each route.

NTPR statewide requires the least amount of new corridor, but two other routes would have lower substation and powerline construction costs. A combination of NTPR west of Bonner and the Hi-Line Route would be the least expensive but would require the second largest amount of new corridor. This is due almost entirely to the planned location of pump stations 7H, 8H, and 9H; they would be located north of the Missouri River and would require 15, 64, and 43 km (9.5, 40, and 27 mi) of 69 kV line construction. (In addition, service to pump station 7H would require the construction of a 161/69-kV substation.) Since pump stations 7H, 8H, and 9H would be located in a sparsely populated and sparsely developed area of the state, few opportunities exist for following existing corridors. The three powerlines probably would result in 15, 12, and 43 km (9.5, 7.5, and 27 mi) of new corridor.

Additional powerline construction is required to serve the block and check valve locations. These valves would require intermittent service at distribution voltage. Since the distribution network is much more extensive than the transmission system, it is possible that less new construction would be required. Because valve locations were specified only for NTPR, no comparisons between routes could be made of powerline requirements.

Land Use

Routes West of Bonner

Land Use: Legal Constraints. Knox Pass is the only route west of Bonner without legal constraints. The most serious legal constraint is found on the Arlee Route where permission to cross the Flathead Indian Reservation would have to be obtained.

Land Use: Specially Managed; Compatibility with Existing Corridors; Linear; and Site Patterns. Due to the variation and number of land use concerns, no attempt was made to rank the routes.

Routes East of Bonner

Land Use: All Concerns. A ranking of these routes was not done because of the number and variations of land use.

St. Ignatius Route

No comparison of the route to any combination of alternative routes was done. This route crosses the Flathead Indian Reservation; NTPC has been refused permission to do this.

Social and Economic Concerns

Routes West of Bonner

Expected housing shortages would be 870 person-nights each for the Arlee and Knox Pass routes and 1,687 for both NTPR and the DNRC Modification Route. NTPR has the lowest construction-period land productivity loss ($14,800) and is equal to the DNRC Modification Route for the second-highest permanent productivity loss ($236,000). The highest temporary loss would occur on the Arlee Route ($22,200). However, the Arlee Route has the lowest permanent productivity loss ($153,000), while the Knox Pass Route has the highest ($259,000).

NTPR, the DNRC Modification Route, and the Knox Pass Route yield eigthy-nine person-years of construction employment for Montanans, while the Arlee Route would yield ninety-eight person-years. No employment could be expected during the operational phase.

The Knox Pass Route yields the highest estimated property tax revenue of the western segments, $67 to $131 million. The Arlee Route would yield $45 to $94 million; the DNRC Modification Route $42 to $82 million; and NTPR, $41 to $79 million. It should be noted that these revenues would not accrue to the same jurisdiction, but rather to the specific taxing jurisdictions traversed by the particular route. Estimates of specific county property tax revenues from the proposed pipeline are presented in **Northern Tier Report No. 6**.

Routes East of Bonner

In the absence of mitigation, all routes east of Bonner would cause significant housing shortages. The Hi-Line Route has the lowest shortfalls of 54,000 person-nights, although potential conflicts with Canadian shoppers exist on this route. The Raynesford Route has the second lowest shortfall at 109,000 person-nights, while the NTPR and the DNRC Modification Route are similar with 134,000 and 131,000 person-nights respectively.

Differences among the routes with regard to construction-period land productivity losses are not very significant. NTPR has the lowest ($163,500), followed by the DNRC Modification and Raynesford routes ($178,600 and $178,800); the Hi-Line Route has the highest ($221,500). With regard to permanent productivity loss, the DNRC Modification Route is lowest ($112,800), followed by the Raynesford Route ($138,400), NTPR ($148,200), and the Hi-Line Route ($152,300).

NTPR and the DNRC Modification Route both yield 292 person-years of employment for Montanans, while the Hi-Line Route yields 286 and the Raynesford Route 283. Fifty-seven permanent jobs for Montanans would result from any route east of Bonner.

The highest property tax revenues would come from the Hi-Line Route—$134 to $279 million. Revenue would be $132 to $256 million from the Raynesford Route, $130 to $253 million from the DNRC Modification Route, and $128 to $250 million from NTPR.

St. Ignatius Route

Housing shortages on the St. Ignatius Route would be greater than those of any combination of routes, with a 168,000 person-night shortfall statewide. Land productivity losses during construction would be $187,200; permanent losses, $275,000.

The St. Ignatius Route is expected to yield 381 person-years of employment for Montanans during construction. The St. Ignatius Route would yield an estimated fifty-seven jobs during pipeline operation.

The St. Ignatius Route is projected to yield $164 to $320 million in property tax revenues statewide.

Cultural Resources

Until an intensive inventory is completed, it is not possible to accurately determine which route would be the most preferable.

Visual Quality

Routes West of Bonner

Construction on any of the four western routes would result in significant long-term visual impact. Each route passes through extensive forest land as well as scenic canyons such as along the Clark Fork and Prospect Creek. There would also be long stretches of cleared right-of-way through dense forest in recreational areas and USFS specially managed areas.

Along the narrow canyon following the Clark Fork between Thompson Falls and Plains, the DNRC Modification Route remains on the north side of the river and crosses a series of cliffs and steep talus slopes. In spite of the nearby highway and railroads, this is a highly scenic area. Other than this problem area, there is no real difference between the four routes west of Bonner.

Routes East of Bonner

The four alternate routes all pass through equivalent areas of "high" and "medium" visual impact (table 42). The Hi-Line Route is marginally the best; NTPR, next best; Raynesford, third; and the DNRC Modification Route, the least desirable. These differences are not considered significant.

St. Ignatius Route

Potentially high visual impact would occur on 186 km (116 mi) of the St. Ignatius Route, as compared with 175 km (109 mi) of a least-impact combination of the DNRC Modification Route west of Bonner an NTPR east of Bonner.

TABLE 47. ESTIMATES RELATING TO THE PROBABLE POWER REQUIREMENTS OF EACH PUMP STATION

PUMP STATION	HORSEPOWER AT 933,000 bpd	REQUIRED SUBSTATION	LINE TO BE CONSTRUCTED	SUBSTATION COST	LINE COST	PUMP STATION TRANSFORMER COST	UTILITY
1N	20,618	100/69	67.2 km (10.75 mi) 69-kV	$500,000	$ 350,000	$40,000	MPC
2N	26,915		<1.6 km (<1 mi) 161-kV		$ 75,000	$60,000	MPC
3N	8,966		.4 km (.25 mi) 100-kV		$ 30,000	$20,000	MPC
4N	20,142		5.6 km (3.5 mi) 100-kV		$ 200,000	$40,000	MPC
5N[1]	12,365[1] 13,552[2]	100/69	28.8 km (18 mi) 69-kV	$500,000	$ 540,000	$40,000	MPC
6N	17,334	230/69	67.2km (42 mi) 69-kV	$800,000	$1,890,000	$40,000	McCone Ed.
7N[1]	15,061[1] 16,163[2]		38.4 km (24 mi) 69-kV		$ 600,000	$40,000	MDV
1H	17,303		6.4-8 km (4-5 mi) 100-kV		$ 200,000	$40,000	MPC
2H	27,503		1.6 km (1 mi) 161-kV		$ 75,000	$60,000	MPC
3H	11,605		230-kV tap		$ 100,000	$20,000	MPC
4H[1]	9,802[1] 14,820[2]		8 km (5 mi) 115-kV		$ 250,000	$40,000	MPC
5H	11,090		<1.6 km (<1 mi) 161-kV		$ 75,000	$20,000	MPC
6H	13,277		5.6 km (3.5 mi) 69-kV		$ 100,000	$40,000	MPC
7H	14,819	161/69	15.2 km (9.5 mi) 69-kV	$500,000	$ 300,000	$40,000	MPC
8H	11,207		40 km (25 mi) 115-kV 64 km (40 mi) 60-kV		$1,500,000-$2,000,000 $1,500,000	 $20,000	N.E.C. MPC
9H[1]	15,162[1] 17,007[2]		43.2 km (27 mi) 69-kV		$ 650,000	$40,000	MDU
1S	11,467		1.6 km (1.0 mi) 100-kV		$ 20,000	$20,000	MPC
2S	13,657		.8 km (.5 mi) 230-kV		$ 200,000	$40,000	MPC
3S	14,146		230 kV tap		$ 100,000	$40,000	MPC
4S	15,205	100/69	24 km (15 mi) 69-kV	$500,000	$ 450,000	$40,000	MPC
1K	7,861		<1.6 km (<1 mi) 100-kV		$ 30,000	$20,000	MPC
2K	9,042		100-kV tap		$ 30,000	$20,000	MPC
4R[1]	15,685[1] 17,632[2]		6.4 km (4 mi) 100-kV		$ 200,000	$40,000	MPC
5R	13,943	100/69	30.4 km (19 mi) 69-kV	$500,000	$ 665,000	$40,000	Fergus
3D	9,996		1.6 km (1.0 mi) 100-kV		$ 30,000	$20,000	MPC
7D[1]	15,061[1] 16,163[2]	115/69	40 km (25 mi) 69-kV	$400,000	$1,125,000	$40,000	McCone
2A	13,055		<1.6 km (<1 mi) 166-kV		$ 75,000	$40,000	MPC

[1] Combination pump and delivery facilities would provide horsepower 75 percent of the time while bypassing storage tanks

[2] Combination pump and delivery facilities would provide horsepower 25 percent of the time while pumping to storage

Soils

Routes West of Bonner

NTPR, the DNRC Modification Route, and the Knox Pass Route have almost identical amounts of terrain with high erosion potential, because each traverses approximately the same distance of steep, mountainous country. In contrast, the Arlee Route has 12 percent less terrain with high erosion potential. This is a significant difference. All four routes are similar with respect to distance through land with medium erosion potential. The Arlee Route crosses fewer streams and goes through far less forested, steep country then do the other three routes. Therefore, it would probably need fewer and shorter access roads and powerlines leading to check valves at stream crossings. Consequently, the Arlee Route has less potential soil erosion then the other three routes.

Routes East of Bonner

NTPR traverses approximately 163 km (101 mi) of soil with high erosion potential. The DNRC Modification Route passes through approximately 11 percent more of these areas; the Raynesford Route, about 5 percent more; and the Hi-Line Route, about 54 percent less. Because of the number of existing roads and powerlines, as well as the flat terrain, the Hi-Line Route would have the fewest soil problems. NTPR is next best, followed by the Raynesford Route, and the DNRC Modification Route; however, there is no significant difference among these three.

St. Ignatius Route

The length of terrain with high erosion potential is 239 km (149 mi), as compared with 188 km (117 mi) on the least-impact combination of the Arlee Route west of Bonner and the Hi-Line Route east of Bonner.

Aquatic Life and Habitats

Routes West of Bonner

Although NTPR and the DNRC Modification Route would have similar potential impact on aquatic life, the DNRC Modification Route has some advantages: (1) it has fewer stream crossings, (2) there is less probability of a mainline oil spill reaching the Clark Fork just east of the series of islands, (3) the crossing of the Clark Fork in this area would require less streambed and bank

TABLE 48. REQUIRED POWER, COST, AND AMOUNT OF NEW CORRIDOR NECESSARY FOR PROVIDING ELECTRICAL SERVICE TO ROUTES

ROUTE	NUMBER OF PUMP STATIONS	MAXIMUM HORSEPOWER REQUIRED	POWERLINE AND SUBSTATION COSTS	NEW CORRIDOR REQUIREMENTS (in kilometers)
NTPR Statewide	7	123,690	5,765,000	49.2 km (30.75 mi)
DNRC Modification Route Statewide	7	124,690	6,720,000	49.6 km (31 mi)
Knox Pass Route and DNRC Modification east of Bonner	8	132,706	5,900,000	49.6 km (31 mi)
Arlee Route and NTPR east of Bonner	8	132,749	5,030,000	49.6 km (31 mi)
NTPR west of Bonner and the Hi-Line Route	9	138,631	4,050,000	75.2 km (47 mi)
NTPR west of Bonner and the Raynesford Route	7	123,093	6,050,000	77.2 km (48.25 mi)
St. Ignatius Route	8	126,821	6,100,000	73.6 km (46 mi)

disturbance than the Clark Fork crossing on NTPR, and (4) there is less potential for impact on the Ninemile Creek drainage.

The Knox Pass Route is the least desirable route from an aquatic standpoint. It crosses more streams, as well as more streams of higher quality, than any other route. It also involves more paralleling and multiple crossings of streams. Between the Idaho border and St. Regis, the Knox Pass Route is particularly bad because it follows narrow mountain stream valleys.

The Arlee Route crosses and parallels fewer waterways than any major western route and probably presents the fewest potential impacts on aquatic life and habitats.

Routes East of Bonner

The DNRC Modification Route is inferior to NTPR because it crosses back into the Clark Fork drainage, involving two more crossings of that river as well as several other class 3 stream crossings. The overall impacts on aquatic life and habitats along NTPR would probably be the least of any alternative if the Missouri River crossings were directionally drilled. By avoiding two crossings of the Missouri and one of the Blackfoot River, the Hi-Line Route has a major advantage over NTPR and the DNRC Modification Route. However, the Hi-Line Route affects more streams within the Blackfoot drainage than do these other two routes and crosses more class 3 streams than any major route east of Bonner.

The Raynesford Route does not avoid the Missouri River crossings and would have impacts on the Blackfoot drainage similar to those from the Hi-Line Route. It has no clear advantage over the Hi-Line Route.

St. Ignatius Route

The route appears to present less potential impact on aquatic life and habitats than the other routes. Fewer streams are crossed by the St. Ignatius Route than any combination of others, and it closely parallels streams for fewer kilometers than any combination. It does not closely parallel any class 1 or 2 streams.

Ground Water

Routes West of Bonner

The DNRC Modification, Arlee, and Knox Pass routes cross 81, 78, and 80 km (50.3, 48.4 and 49.7 mi) respectively of areas in category 4; NTPR crosses 88 km (55 mi) in category 4, about 9 percent more than each of the other routes. The difference among routes is greater when comparing category 5 risk areas: NTPC crosses 29 km (18 mi) in category 5; the Knox Pass Route, 24 km (15 mi) or 18 percent less than NTPR; the Arlee Route, 16 km (10 mi) or 45 percent less; and the DNRC Modification Route, 12 km (7.4 mi) or 59 percent less. The Knox Pass Route closely passes four towns which get part or all of their water supply from ground water. Each of the remaining three routes passes two such towns.

Thus, considering potential impacts to ground water, NTPR and the Knox Pass Route are the least desirable. The Arlee Route is significantly better, and the DNRC Modification Route is best by a small, probably not significant, margin over the Arlee Route.

Routes East of Bonner

Overall, ground water on the DNRC Modification Route would be marginally more at a risk than on NTPR. The most important difference between these two routes and the Hi-Line Route is a significant increase in risk category 3 and a signifcant decrease in risk categories 4 and 5 on the Hi-Line Route. The Raynesford Route has significantly less risk category 3 than the other routes and is intermediate for risk categories 4 and 5.

The four routes are almost equal in total risk to ground water, with the Hi-Line Route being of slightly lower risk than the others. The DNRC Modification and the Raynesford routes are marginally worse than NTPR, primarily because of the greater number of wells and town ground-water supplies passed. None of these differences are considered significant or useful in choosing between the four routes.

St. Ignatius Route

Considering overall ground water risk, the St. Ignatius Route is significantly worse than any other possible combination of routes. It crosses 44 km (27 mi) in ground-water risk category 5 (highest risk)—10 km (6 mi) more than the lowest risk combination of the Arlee and Hi-Line routes—and 230 km (143 mi) of category 4, which is more than on any possible combination of other routes.

Vegetation and Land Productivity

Routes West of Bonner

NTPR, the DNRC Modification Route, and the Knox Pass Route are predominantly forested, while the Arlee Route is forested over half of its length. The greatest length of forest land is crossed by the DNRC Modification Route, although the Knox Pass Route crosses more land in the most highly productive habitat types (productivity ratings 1 and 2, table 33 p. 82) and would require the greatest amount of new clearing of forest. There is some opportunity for sharing of existing cleared rights-of-way on all routes.

The routes would cross between 2 and 15 km (1.3 and 9 mi) of irrigated cropland and from 2 to 14 km (1.3 to 8 mi) of dry cropland. The Arlee Route crosses the greatest amount of irrigated cropland, as well as the greatest amount of total cultivated land of all routes. The Knox Pass Route crosses the least amount of irrigated cropland but the greatest amount of dry cropland; NTPR crosses the least amount of dry cropland.

Routes East of Bonner

Relatively little forest land is crossed by any of these routes, but the DNRC Modification Route crosses considerably less than the others. All routes allow some mitigation of impact by potential sharing of existing cleared rights-of-way.

Differences in lengths of cropland crossed are more pronounced east of Bonner. The DNRC Modification Route crosses the greatest amount of irrigated cropland (slightly more than NTPR) and the Raynesford Route crosses the least. The Hi-Line Route crosses by far the most dry cropland and total cropland, while NTPR crosses the least.

St. Ignatius Route

This route crosses more forest land as well as more irrigated cropland than any combination of other routes.

Wildlife and Habitats

Table 49 lists combinations of routes east and west of Bonner which are the most and least desirable concerning wildlife.

Routes West of Bonner

All routes west of Bonner cross considerable amounts of big game winter range, upland game bird habitat, and raptor nesting habitat. NTPR crosses substantially more elk winter range and more severe winter concentration areas of elk than the other alternatives; it is also the only route which crosses a major elk summer security area. The DNRC Modification Route poses the greatest risk of impact to bighorn sheep, as it traverses an important wintering area east of Thompson Falls. Risk of impact to mule deer and white-tailed deer does not differ greatly among the routes, although NTPR has a somewhat higher risk than do the other routes. Grizzly bear habitat is traversed by all but the Knox Pass Route.

Routes East of Bonner

The routes east of Bonner are similar in their relative risk of impact to elk and bighorn sheep, as all cross comparable amounts of elk winter range and none cross bighorn sheep winter range. The DNRC Modification Route crosses far more moose winter range than the other routes. While the DNRC Modification Route crosses the most pronghorn winter range, the Raynesford Route crosses the greatest distance of pronghorn severe winter concentration areas. The Raynesford Route and NTPR respectively cross the greatest amount of mule deer winter range and areas of severe winter concentration. The Raynesford Route also crosses the most white-tailed deer winter range, but the Hi-Line Route crosses the most white-tailed deer severe winter concentration areas. The Raynesford Route crosses the most sage and sharp-tailed grouse habitat, while the Hi-Line Route crosses the least. Both the Hi-Line and Raynesford routes cross considerable grizzly bear habitat near Lincoln.

The Hi-Line Route passes near Medicine Lake National Wildlife Refuge, which is used by the endangered whooping crane during migration, and crosses far more waterfowl habitat than does any other route.

St. Ignatius Route

The tabulations do not allow direct comparison of this route with the other alternatives in terms of length of wildlife habitats crossed. Grizzly bear habitat, including some designated as "critical" is crossed between St. Ignatius and Placid Lake, and a recently active bald eagle nest is approached west of Ovando.

Climate and Air Quality

There is no comparable difference among the routes.

TABLE 49. COMPARISONS OF ALTERNATIVE ROUTES ACROSS MONTANA (excluding the St. Ignatius Route) WITH RESPECT TO WILDLIFE[1]

WILDLIFE CONCERN	BEST ROUTE	LEAST DESIRABLE
Waterfowl Total Habitat	Knox Pass + Raynesford	NTPR + Hi-Line
Waterfowl Excellent Habitat	Any + Raynesford	Any + Hi-Line
Mountain Grouse Total Habitat	Arlee + DNRC	NTPR + Raynesford
Sharp-Tailed Grouse Total Habitat	Any + Hi-Line	Any + Raynesford
Sharp-Tailed Grouse Excellent Habitat	Any + NTPR	Any + Raynesford
Sage Grouse Total Habitat	Any + Arlee	Any + Raynesford
Sage Grouse Excellent Habitat	Any + Hi-Line	Any + Raynesford
Ring-Necked Pheasant Total Habitat	Arlee + NTPR	DNRC + Raynesford
Proposed Critical Grizzly Bear Habitat	Any + (NTPR, DNRC)[2]	Any + (Hi-Line, Raynesford)
Elk WR[3]	Arlee + (Hi-Line, Raynesford)	NTPR + NTPR
Elk CSW	Arlee + (NTPR, DNRC)	NTPR + (Hi-Line, Raynesford)
Mule Deer WR	Knox Pass + Hi-Line	NTPR + Raynesford
Mule Deer CSW	Arlee + Raynesford	NTPR + NTPR
White-Tailed Deer WR	Knox Pass + NTPR	NTPR + Raynesford
White-Tailed Deer CSW	Arlee + (NTPR, DNRC)	NTPR + Hi-Line
Moose WR	(NTPR, DNRC, Knox Pass) + NTPR	Arlee + DNRC
Pronghorn WR	(NTPR, DNRC, Knox Pass) + Hi-Line	Arlee + DNRC
Pronghorn CSW	Any + DNRC	Any + Raynesford
Bighorn Sheep WR	Knox Pass + Any	DNRC + Any

[1] The St. Ignatius Route was excluded from this table because of the lack of comparable wildlife data for the Flathead Indian Reservation area.
[2] Abbreviations as in table 42. Where tabulations for alternatives are identical, they are given in parentheses.
[3] WR = Winter Range, CSW = Concentration areas during severe winters.

CHAPTER EIGHT

LONG-TERM, IRREVERSIBLE, AND GROWTH-INDUCING EFFECTS OF THE PROPOSED NORTHERN TIER PIPELINE

The Montana Environmental Policy Act (MEPA) requires, for each action that requires an environmental impact statement, consideration of irreversible and irretrievable commitment of resources, insignificant and significant impacts, short- and long-term impacts, growth-inducing and growth-inhibiting effects, and nonmitigable adverse impacts. Some of these concerns were discussed in chapter six as they pertained to particular environmental and social effects of the Northern Tier Project on Montana. This chapter discusses those MEPA concerns that relate to the overall impact of the project.

IRREVERSIBLE AND IRRETRIEVABLE COMMITMENT OF RESOURCES

Besides materials used for construction—such as metal for the pipe—and land used for the permanent placement of pipeline facilities, committed resources would include large amounts of fossil fuel (see table 50, p. 108). While the steel in the pipe may someday be reclaimed, the fossil energy which was expended in the mining, transporting, and smelting of ore, as well as in the manufacturing, tooling, and transporting of the pipe, cannot be retrieved. The Northern Tier proposal would also indirectly promote the irretrievable use of crude oil by increasing the availability and thus hastening the depletion of this finite resource.

GROWTH-INDUCING AND GROWTH-INHIBITING EFFECTS

Pipeline construction would undoubtedly trigger some economic growth. For instance, small businesses such as food stores and suppliers of construction materials may increase their stock in anticipation of increased business. Increased population, although temporary, would also stimulate economic growth. During operation, the increased crude-oil supply may result in industrial growth such as expansion of area refineries or development of petrochemical feedstocks. The additional oil supply, however, may inhibit oil exploration or expansion of existing production.

LONG-TERM IMPLICATIONS OF THE PROPOSAL

MEPA requires that the relationship between local short-term uses of our environment and the maintenance and enhancement of long-term productivity be considered. Although the preceding chapters address this concern for the Northern Tier Pipeline on a local level, primarily as it affects Montana, the long-term impacts of the project must be examined in a larger context. The Northern Tier Project is one of many major energy projects being pursued in the U.S. to rectify the energy problem. For the most part, these projects are a continuation of historical energy-use patterns. To examine just the Northern Tier Project without at least a cursory discussion of the possible cumulative impacts of these projects, which portray the current approach to the energy dilemna, is short-sighted. The long-term implications of this pipeline as it relates to the enhancement of long-term productivity may be insignificant, but when examined in totality with the overall energy problem, other implications surface.

Crude-oil supply shortages in Montana are the localized expression of a nationwide supply shortage resulting from a complex pattern of historical events. It is fairly clear that the current shortages in the U.S. result primarily from (1) the increased demand for petroleum products; (2) a general depletion of readily accessible domestic crude oil reserves, which has led to increased reliance on imports; and (3) the growing difficulty and uncertainty of obtaining foreign crude. In the search for a simple explanation for the energy crisis, there has been a tendency to place the blame on OPEC or on a failure of the nation's crude-oil suppliers and the government to respond to the imbalance of supply and demand. However, the basic fact remains—the world's finite reserves of crude oil and other fossil fuels are being depleted at an ever-increasing rate.

Fossil fuels, of which crude oil and its derivatives are currently the most important, provide nearly all of the energy on which we depend. Food is grown on land fertilized by compounds produced by petroleum energy, treated with petroleum-derived pesticides, and harvested, sorted, packaged, and transported by petroleum-fueled machinery. (By 1970, U.S. agriculture required nine calories of fossil energy to produce one calorie of food, according to Gilbert and Kaufman 1977.) Twenty-five percent of the nation's energy budget is consumed by transportation, which is nearly 100 percent dependent on petroleum and uses more than half of all petroleum used in the United States (Golden et al. 1979). At this current rate of consumption, world oil reserves will essentially be depleted early in the next century, and crude oil will cease to be a major energy source in this country. Change in energy-use patterns is inevitable.

The immediacy of daily problems encourages the tendency to view the world on the basis of short-term gains. These gains, however small, often overshadow costs that are not immediately apparent or that do not directly affect those responsible. For example, early miners in the western states used any expedient means to extract minerals quickly and cheaply, and then moved on; the costs of their actions in terms of environmental damage have persisted a cen-

tury or more in some cases. This perspective characterizes a common reaction to the current energy situation, entailing proposals to provide more energy over the short term and deferring serious consideration of eventual long-term consequences, including the inevitable change in energy-use patterns. This viewpoint demands that the energy supply be increased by any means and at whatever long-term cost is necessary, as long as the market will accommodate the immediate costs. The Northern Tier Pipeline System would be such a short-term solution, providing crude oil for the next two decades.

TABLE 50. NATURAL RESOURCES IRREVERSIBLY COMMITTED BY CONSTRUCTION AND OPERATION OF THE NORTHERN TIER PIPELINE SYSTEM (excluding port facilities)

RESOURCE	AMOUNT COMMITTED
Steel	695,558 tons[1]
Sand, gravel, and cement used in concrete	10,431 yd³
Select fill	80,000 yd³
Copper	121 tons
Lumber	117,000 board feet
Labor (direct employment)	5,001 person-years
Labor (indirect employment in steel industry)	500,000 person-hours
Electric power requirements	1092-2160 MM KWH[2]
Gasoline and Diesel Fuel	Unknown

SOURCE: USDI 1979
[1] Not all is irreversibly committed, most can be reclaimed
[2] MM KWH = million kilowatt hours

Any short-term solution postpones the time when the U.S. will accomplish the barely begun transition from an economy based on fossil fuel consumption to one based on other fuel sources. Many people believe that as we continue to rapidly consume the last of the world's crude oil reserves, technology will develop last-minute substitute energy sources that can be produced in quantities sufficient to maintain the current level of use. However, past transitions from wood to coal and from coal to oil took many years and necessitated a complete technological turnover (Gilbert and Kaufman 1978). It is likely that, unless more vigorous steps are taken to accelerate this transition soon, the U.S. may be unprepared to cope with the problem. Short-term solutions, therefore, may not only be contrary to the national interests of sustaining and enhancing long-term productivity, but may also be counter-productive. The illusion of an abundant supply of energy reduces incentives to curtail wasteful use and to switch to nonfossil energy sources.

A long-term solution to the crude oil shortage could focus on stabilizing or reducing energy demand rather than increasing supply. Energy use could be reduced by increasing the efficiency of producing goods and services without decreasing the actual output. For instance, transportation could be provided while the amount of required fuel is reduced by increasing the efficiency of automobile engines, developing alternative fuel sources, or by changing transportation patterns to a greater reliance on car pooling and mass transit.

The sustainable energy sources (such as solar, wind, and biomass) could also help provide a long-term solution. Use of passive solar design in all new homes built in the U.S. over the next twelve years would save about as much energy as is expected from the Alaskan North Slope (Bliss 1976). However, sustainable energy sources would need considerable financial support and encouragement from both government and the private sector to approach the present level of energy consumption.

Some change in energy-use patterns will occur as a response to market conditions. Escalating fuel costs will bring at least a partial change in fuel consumption. As petroleum becomes more scarce in relation to growing demands of all kinds, the price will rise and be a rationing device to allocate available supplies among competing users. As prices rise, there will be a shift to more efficient vehicles, greater use of mass transit, and changes in locational patterns and property values in favor of compact settlement patterns. Alternative sustainable sources of fuel will become more economically viable as supplies diminish.

The Northern Tier Pipeline System would be just one solution to a complex energy problem. It is an answer to today's shortages, yet may not address the long-term implications of the energy shortage.

APPENDIX A

EQUIPMENT NEEDED FOR A TYPICAL CONSTRUCTION SPREAD

EQUIPMENT LIST FOR TYPICAL PIPELINE CONSTRUCTION SPREAD

DESCRIPTION	NUMBER REQUIRED	DESCRIPTION	NUMBER REQUIRED
Dozer, D-8	18	Truck, Fuel	2
Dozer, D-8 with Ripper	2	Truck, Grease	1
Dozer, D-7	13	Jeep	2
Tractor, Crawler, D-8 with Sideboom	9	Bus	5
Tractor, Crawler, D-7 with Sideboom	9	Backfiller	1
Tractor, Crawler, D-6 or D-7	15	Buffing Rig with Air Compressor	1
Tractor, Farm	3	Air Compressor	8
Grader, Road, Tandem Drive	1	Lineup Clamp, Internal	2
Ditcher, Wheel	2	Power Saw	6
Loader, Front End	2	Chipping Machine	2
Backhoe, Crawler, 2 Yard	14	Rock Drill	5
Backhoe, Crawler, 1½ Yard	1	Rock Picker	2
Pipe Bending Machine 40"-42" with Mandrel	1	Boring Machine, 48"	1
Welding Rig	2	Pump, Low Pressure (Line Fill)	1
Welding Machine, 300 Amp.	26	Pump, High Pressure (Hydrostatic Testing)	1
Dragline, 2 Yard	1	Pump, Sump, 3"	4
Dragline/Clam, 1½ Yard	6	Strainer, Dual Phase	1
Truck with "A" Frame and Winch	5	Mobile Laboratory	1
Truck, Flatbed	5	Barge	1
Truck, Dump	6	Launch	1
Truck, Float/Lowboy	5	Trailer, Field Office	1
Truck, Pipe Stringing	11	Van, Parts	3
Truck, Mechanic's	6	Automobile	3
Truck, X-Ray	5	Radio Base Station	1
Truck, Pickup	101	Mobile Radio Set	As Required
Truck, Crew	2	Miscellaneous Hand and Power Tools	As Required

SOURCE NTPC 1978

CORRESPONDENCE FROM NTPC REGARDING HYDROSTATIC TESTING

Butler ASSOCIATES INC P.O. Box 45207 Tulsa Oklahoma 74145 Phone 918 622-9161 Cable BUTLER Telex 49 23 93

April 9, 1979

Mr. David N. Janis
Department of Natural Resources
and Conservation
Energy Planning Division
32 South Ewing
Helena, Montana 59601

Dear Dave,

The hydrostatic test procedures will not be prepared until the final design of the pipeline is accomplished due to the fact that the exact profile of the pipeline must be known. The location elevation and pipe wall thickness must be known to calculate the test pressure and to segment the pipe for the test.

The hydrostatic testing of the pipeline will be conducted in accordance with U. S. Department of Transportation Regulations Part 195 "Transportation of Liquids by Pipeline", Subpart E "Hydrostatic Testing" and by reference, American National Standard Institute ANSI B 31.4 "Liquid Petroleum Transportation Piping Systems" paragraph 437.4.1 "Hydrostatic Testing of Internal Pressure Piping." Basically, the hydrostatic test will consist of pressurizing the pipeline with water to at least 1.25 times the internal design pressure and holding at that pressure for 24 hours. During the test period, line pressures and temperatures will be continuously recorded and monitored. The hydrostatic test procedures will outline the maximum and minimum pressures acceptable for each particular line segment. Any leaks will be repaired and a new hydrostatic test initiated. All portions of the pipeline will be successfully tested before the system can become operational.

The hydrostatic test water acquisition sources, discharge locations and stipulations of the required permits per the applicable state and federal regulations will be adhered to by Northern Tier Pipeline Company.

Please call if you should have any questions.

Sincerely,

M J Crocker

M. J. Crocker

MJC:rs:197
cc: Mr. T. C. Kryzer
Dr. M. C. Deibert

9910 East 42nd Street Tulsa Oklahoma

DNRC'S CENTERLINE PROPOSAL AND NTPC'S RESPONSE

Thomas L. Judge, Governor

MONTANA DEPARTMENT OF NATURAL RESOURCES & CONSERVATION

MEMBERS OF THE BOARD - CHAIRMAN CECIL WEEDING J VIOLA HERAK, Gordon Holte DR WILSON F CLARK DR ROY E HUFFMAN WILLIAM H BERTSCHE CHARLES L HASH

DNRC

Ted J. Doney, Director

May 9, 1979

Mr. Tom C. Kryzer, President
Northern Tier Pipeline Company
509 Midland Bank Building
Billings, Montana 59101

Dear Mr. Kryzer:

It is my understanding that Northern Tier would like to be granted the appropriate state rights-of-way prior to applying for the actual permits. If granted, Northern Tier would then be willing to fund the State to carry out the additional work necessary to establish and enforce permit stipulations, such as centerline selection and construction surveillance. If this is the case, I advise we begin to outline the specifics as well as amend our present agreement so the work can proceed uninterrupted. According to Section 7 and Exhibit "A" of our Agreement, Northern Tier Pipeline Company can request the Department to form additional work or render services in connection with this Agreement.

After a route has been agreed upon, I believe the centerline evaluation is the most appropriate place to begin to formulate permit stipulations. As you know, I have recommended that Northern Tier and the Department enter into an agreement on a site-specific evaluation of the centerline, including evaluations for permits stipulations. My November 30, 1978 letter outlines the basic arrangement; I will now explain in further detail what I envision the agreement to be.

As soon as the state can legally take action on the rights-of-way, DNRC personnel and Northern Tier representatives can begin work jointly in the field to identify the centerline. This would include evaluation of stream crossings by Conservation Districts, as well as the other permits which must be obtained.

I am confident that when Northern Tier is ready to survey the route, we will be prepared to work with you. It is essential that the Department conduct field evaluation of the centerline once it has been selected.

I hope to hear from you very soon on this matter.

Sincerely,

Richard T. Munger

Richard T. Munger, Acting Director

RTM/jsk

Enclosures

cc: Dave Janis, DNRC
Max Deibert, ERT, Inc.
Max Crocker, Butler Associates

32 SOUTH EWING, HELENA, MONTANA 59601 (406) 449-3712

PROPOSED CENTERLINE STUDY

NORTHERN TIER PIPELINE

This proposal details a procedure for the site-specific evaluation of the pipeline centerline, including stream crossing evaluations.

CENTERLINE PROCESS

The centerline evaluation process consists of four tasks. After a route for the pipeline has been selected, the Department's centerline team will:

1. Work with Northern Tier, (pipeline engineers, right-of-way specialist, scientist, survey and staking crews and others) to jointly identify a centerline for the pipeline that represents minimum adverse impact and to identify sensitive areas requiring special timing or construction techniques. Much of the centerline work would be done on maps before survey and staking the centerline. If differences in centerline location in sensitive areas (as identified by the Department) occur, the Department and Northern Tier will meet and work out a mutually acceptable solution;
2. Prepare Supportive centerline information regarding environmental and land use concerns for state regulatory agencies to aid the permit and easement process;
3. Prepare general and site-specific information on mitigation of pipeline-related impacts on the centerline for pipeline surveillance inspectors and for state regulatory agencies to help formulate permit and easement stipulations;
4. Determine type and frequency of inspectors needed for the state's surveillance of pipeline construction and reclamation activities.

THE EVALUATION TEAM

A field evaluation team will be assembled and managed by the Department of Natural Resources & Conservation (DNRC) to begin the centerline evaluation. The team should be composed of the following:

1. Aquatic Biologist: Evaluation for stream crossing permits. Identification and mitigation of access road impacts.
2. Engineering Geologist: Identification of erosion, drainage, and other geology problems. Identification and mitigation of access impacts at river crossings.
3. Terrestrial Biologist: Identification and mitigation of soil and reclamation impacts.

Other state agency personnel could act as back-up to the team on an "as-needed" basis.

The team will work closely with other state agencies to ensure compliance with their statutory obligations. Throughout the entire process, team members will be responsible for compiling centerline evaluation reports which will record field information for future monitoring.

Essentially all phases of the field evaluation addressed below will proceed concurrently.

FIELD WORK

It is essential that the field evaluation of the centerline proceed without interruption after a route has been selected, especially for the more sensitive

areas along the route. The team should be scheduled to go into the field in early spring, enabling it to collect data through the spring-fall field season.

SURVEY AND STAKING

The field evaluation team will work with Northern Tier survey teams during surveying and staking of the centerline.

ON-THE-GROUND INSPECTION OF THE STAKED CENTERLINE

All portions of the staked centerline will at sometime during the field evaluation be inspected on the ground by the evaluation team.

STREAM CROSSING EVALUATIONS

The stream crossing evaluations necessary for the 310 permits would be done during the centerline evaluation process. The team's aquatic biologist would represent the Montana Department of Fish, Wildlife and Parks.

STATUTORY AND REGULATORY AUTHORITY

The centerline evaluation team will be able to provide the kind of specific information required by state regulatory agencies in order to issue permits and easements. Following is the list of statutory and regulatory authority of those state agencies.

1. Easement to Cross State Lands

Authority:	Title 77, Chapter 2, Part 1, M.C.A.
See Also:	The Montana Open Space Land Act. Title 76, Chapter 6, Part 1, M.C.A.; The Montana

	Antiquities Act, Title 22, Chapter 3, Part 4, M.C.A. (Historical Society); The Montana Natural Areas Act, Title 76, Chapter 12, Part 1, M.C.A. ARM 26-2.14(4)-S1410; Rights-of-Way to Cross Forest Lands, Section 77-S-202 and Section 77-5-103, M.C.A.
Principal Agencies Reponsible:	Department of State Lands; Department of Natural Resources & Conservation, Forestry Division.

2. Easement to Cross Streams and Highways

Authority:	Section 69-13-103 and Section 69-13-104, M.C.A.; Section 7-14-2139, M.C.A.; ARM 18-2 6A1 (2) S6020 et seq.; ARM 16-2.14(10)-S14320, 14381.
Principal Agency Reponsible:	Department of Highways.

3. Natural Streambed and Land Preservation Act

Authority:	Title 7S, Chapter 7, Part 1, M.C.A. In addition to the statute cited above, Model Rules for Implementation of the Natural Streambed and Land Preservation Act for 1975 as adopted by the Board of Natural Resources & Conservation. Also, each local conservation district had adopted

	local standards and guidelines.
Principal Agency Responsible:	Board of Local Supervisors, Soil and Water Conservation District.
Authority:	Title 87-1-210, M.C.A.. Memorandums of Understanding relative to the Natural Stream & Land Preservation Act with the Forest Service, Bureau of Land Management, and the United States Fish & Wildlife Service.
Principal Agency Responsible:	Montana Oepartment of Fish, Wildlife & Parks.
Authority:	26104.7 (The Coordination Act). Gives input in riparian-related projects subject to Section 404 of tne Federal Water Pollution Control Act Amendments of 1972.
Principal Agency Responsible:	Montana Oepartment of Fish, Wildlife & Parks.
Authority:	Section 6(9) (Water Pollution Control Act). Memorandum of Understanding with the Montana State Department of Health & Environmental Sciences.
Principal Agency Reponsible:	Montana Department of Fish, Wildlife & Parks.
Authority:	Section 87-1-303, M.C.A.. Regulation of all land owned or leased by Fish, Wildlife & Parks.

Principal Agency Responsible:	Montana Department of Fish, Wildlife & Parks.
Authority:	Section 87-1-201, M.C.A. Protect all fishes and wildlife.
Principal Agency Responsible:	Montana Oepartment of Fish, Wildlife & Parks.
Authority:	Section 26-1510, et seq., M.C.A. Participate as a member of the inspection team.
Principal Agency Responsible:	Montana Department of Fish, Wildlife & Parks.

4. <u>Flood Plain Management Act</u>

Authority:	Floodway Management Act, Title 76, Chapter 5, Part 1, M.C.A.; ARM 36-2. 14B(1) S1400 et seq.
Principal Agency Responsible:	Oepartment of Natural Resources & Conservation, Floodway Management Bureau, or county authorities (if they have adopted regulations).

Northern Tier Pipeline Co.

MIDLAND NATIONAL BANK BLDG. • SUITE 509
PHONE 406-248-1388 • BILLINGS, MONTANA 59101

June 1, 1979

Mr. Ted J. Doney, Director
Montana Department of Natural Resources
and Conservation
32 South Ewing
Helena, Montana 59601

Re: Letter of May 9, 1979, Munger/Kryzer: Proposed Centerline Study

Dear Mr. Doney:

After review of the referenced letter and the proposed centerline study, Northern Tier Pipeline Company has several comments:

NTPC will make application to receive grants of right-of-way across state lands, streams and highways and approvals to cross floodplains prior to conducting centerline-specific studies and surveys. The application for these grants will include the preferred route shown on the photo-alignment sheets which NTPC has already supplied to the state and which identify the proposed centerline within a resolution of 100 feet or so. We expect that the grants of right-of-way from the appropriate state authorities will include stipulations for specific centerline studies and means of determinations of specific centerline locations on state-owned or controlled lands. These studies would be conducted prior to the initiation of construction. The centerline studies you have proposed may be those which the right-of-way permitting authorities will require as permit stipulations. A copy of your proposal will be submitted with the application to the Department of State Lands for right-of-way across state lands.

The basic reason NTPC desires to perform specific centerline studies and determination as stipulations on already-granted rights-of-way is to avoid conflict at the boundaries of state-owned or controlled parcels with federal or private owners of adjacent lands along the right-of-way. After issuing the grant of the right-of-way across federal lands, the federal government will conduct centerline-specific studies on its land parcels as a condition of that grant from the Bureau of Land Management. In addition, the process of NTPC's negotiating the rights-of-way on privately-owned lands will develop essential information on the desires of the landowners for the location of the centerline. In each case, NTPC will work with the owners of adjacent land parcels to insure that their

Ted J. Doney
June 1, 1979
Page 2

mutual interests are respected, including the location of the centerline at the boundaries of state and private lands and at the boundaries of state and federal lands. NTPC, of course, will not initiate the negotiation of rights-of-way with private landowners until it has received the basic project permits, including grants of right-of-way from the state and federal governments. Performing centerline-specific studies on state-owned or controlled lands prior to the issuance of these permits and grants could establish centerline positions on state lands which would conflict with the interests of adjacent landowners and result in a wasteful duplication of effort at a later date.

It is not clear from your proposed centerline study that it is limited to state-owned or controlled lands. We assume this to be the case since the state-employed reviewers of the centerline cannot, of course, expect to represent the interests of the federal government on its lands or of private landowners on their lands. NTPC's review of the authorities presented in the centerline study plan indicates that these authorities are over the specific location and conditions of construction and operation on state-owned lands, certain stream and highway crossings and in floodways. The budget estimate appears to be high for studies only on state-owned and controlled lands. NTPC expects to pay the cost of these studies conducted between the granting of the project authorizing permits and the initiation of construction.

Each final right-of-way agreement negotiated with state, federal and private landowners will commit NTPC to comply with the construction and operating conditions established as most reasonable and responsive to environmental values, as committed to by NTPC in various mitigation measures. Some of these mitigation measures have already been committed to by NTPC, and others may be adopted as the result of information developed in the environmental review process.

NTPC's basic comments on the proposed centerline study include:

1) The study plan should define the areas to be covered in the investigation. We assume the state does not intend to preempt the rights of federal and private landowners to establish the location of the centerline on their lands.

2) The studies, from NTPC's standpoint, would be conducted on state-owned and controlled lands as a stipulation on previously-granted permits. The study plan repeatedly makes the assumption that the studies are to be conducted to develop the information required to issue

permits and easements, rather than as a condition of compliance with already-issued permits. NTPC assumes that the study results will be utilized to establish additional conditions of compliance with these already-issued permits.

We will look forward to further development with you and the permit-issuing agencies of a program of specific centerline studies to be performed prior to construction on state-owned or controlled lands. We are sure that the definition of and commitment to these studies will insure that all the information needed by the relevant state authorities to establish the most environmentally-acceptable centerline location will be available.

The United States Department of Transportation has statutory responsibility for and has established detailed rules and regulations concerning the environmental and safety aspects of all crude oil pipelines. These regulations encompass the design, construction and operation of all such pipelines, and the entire length of such pipelines without regard to the ownership of the land. The Department of Transportation thus has the responsibility to insure that the Northern Tier Pipeline Company complies with such environmental and safety constraints as imposed by the regulations as well as any others which may be imposed upon them by the President's decision.

Sincerely yours,

T C Kryzer

T. C. Kryzer
President

TCK:jcs

APPENDIX D

CORRESPONDENCE FROM THE MONTANA POWER COMPANY REGARDING ELECTRICAL POWER SUPPLY

MONTANA POWER COMPANY mpc GENERAL OFFICES 40 EAST BROADWAY BUTTE MONTANA 59701 • TELEPHONE 406/723 5421

May 15, 1979

Mr. Larry Nordell
Montana Department of Natural Resources
and Conservation
32 South Ewing
Helena, MT 59601

Dear Larry:

At Gene Braun's request, I am writing you to discuss The Montana Power Company's electrical power supply situation regarding service to Northern Tier Pipeline's Company's requirements in our service area.

Our latest information concerning their loads is that they will require from The Montana Power Company beginning in late 1981 or early 1982 a total of 38 to 40 MW at a monthly load factor of about 87%. Beginning in about late 1984, their total requirement would increase to 70 to 75 MW at monthly load factor of about 93%.

Although we have stated that we can supply the necessary transmission and distribution facilities to service the proposed pumping sites, our committment to supply the necessary power and energy is less certain. Until such time as the Colstrip #3 unit is ready for commercial operation (currently estimated to be in the late fall of 1983, assuming a re-start of construction by fall of 1979), we can only supply energy for the Northern Tier Pipeline load on a non-firm basis. After Colstrip #3, we could firmly commit to supply both their initial and ultimate loads.

In the period January, 1982 through the fall of 1983, our current planning studies show that our energy supplies under adverse hydro-electric conditions will be deficient in meeting our estimated load, even without the Northern Tier Pipe Line load. Under median hydro our energy supply will just meet our current estimated load, without Northern Tier.

We would expect then to supply Northern Tier's requirements in the period prior to Colstrip #3 on a non-firm basis from

oil-fired generation at our Bird plant (if we can obtain sufficient low-sulphur oil and if we were permitted to burn it), and from occasional purchases of surplus oil-fired generation which might be available from time-to-time elsewhere in the western U.S. Further delay of the Colstrip #3 and #4 schedule would make this already tenuous supply more insecure.

A firm committment after Colstrip #3 would probably require advancing the schedule for our next planned base-load energy resource from 1989 to 1988.

I hope this gives you sufficient information for your requirements.

Sincerely yours,

Donald B. Gregg

D. B. Gregg, Manager
Power Contracts, Resources
and Planning

DBG/la/D:2

CORRESPONDENCE FROM NTPC REGARDING SEISMIC STUDIES

Northern Tier Pipeline Co.

MIDLAND NATIONAL BANK BLDG. • SUITE 509
PHONE 408-248-1388 • BILLINGS, MONTANA 59101

March 29, 1979

Mr. David H. Janis, Project Manager
Northern Tier Pipeline
Department of Natural Resources & Conservation
32 South Ewing
Helena, Montana 59601

RE: Planned Investigations for Seismic Design--Northern Tier Pipeline System Montana Routing and Facilities

Dear Mr. Janis:

This letter states the formal notification of the Northern Tier Pipeline Company intent to perform special investigations of seismic conditions in the state of Montana relative to design needs of the proposed Northern Tier Pipeline System and related facilities. We recognize the potential effects from seismic activity to the pipeline and are conducting these studies to insure that the pipeline is designed to mitigate these effects.

Toward that end, we have retained the services of S. A. Alsup Associates, Inc., of 2344 Commonwealth Avenue in Newton, Massachusetts, to perform the necessary investigations and provide input design parameters. As you know, Dr. Alsup is very familiar with both the pipeline and Montana geology, and we expect that a thorough and competent effort will be provided. Analysis of the existing seismicity information is currently underway, and field investigations (if necessary) will occur in the spring and summer months of this year.

Please let me know if you have any questions on this matter.

Yours very truly,

T C Kryzer

T. C. Kryzer, President

TCK:jls

cc: Max Crocker
Max Deibert
Ward Shanahan
Jim Hodge

APPENDIX F

INDEX TO USDOT'S MINIMUM FEDERAL SAFETY STANDARDS FOR LIQUID PIPELINES

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APPENDIX G

DESCRIPTION AND POTENTIAL IMPACTS OF THE ALTERNATIVE ROUTES

ROUTES WEST OF BONNER

Northern Tier Proposed Route (NTPR)

This route enters Montana at Thompson Pass, 1,480 m (4,859 ft), and follows the Prospect Creek flood plain until entering the Clark Fork Valley south of Thompson Falls. The Clark Fork is crossed at Thompson Falls and again at a series of islands about 3.2 km (2 mi) east of the mouth of the Thompson River. From there, the route parallels the south bank of the Clark Fork southeast to the Weeksville area, crosses a forested area 1.6 to 3.2 km (1 to 2 mi) upslope from the river to the Plains area, and then again parallels the south bank of the Clark Fork to the U.S. 10-A bridge south of Paradise. There the river is crossed, and the route follows Highway 461 east to the mouth of Siegel Creek. Proceeding southeastward up the steep, narrow canyon of Siegel Creek, NTPR crosses Siegel Pass at 1,560 m (5,121 ft), dropping into the Ninemile Creek drainage. The route continues southeast to Frenchtown, generally following less than 1.6 km (1 mi) upslope (north) of Ninemile Creek and the Clark Fork beyond the mouth of the creek. From Frenchtown, the route continues to Bonner, crossing Rattlesnake Creek approximately 1.6 km (1 mi) north of the Rattlesnake School and passing north of Mount Jumbo and East Missoula.

Terrain, Engineering, and Hydrologic Hazards

This route goes through three major problem areas. Along Prospect Creek, special construction methods would be required to minimize streambed disturbance and sediment production, and to prevent exposure of the pipe and damage to the streambed during operation. (Construction methods are discussed in chapter five, p. 40). Stream bottom scour during flooding has previously uncovered the Yellowstone Pipeline in several places under this creek.

The Quinn's Hot Springs area, which extends from the junction of the Flathead River and the Clark Fork south to the mouth of Siegel Creek, is a narrow, rock-walled canyon. Rock cuts would have to be blasted for about 1.4 km (.8 mi) to make room for construction through the canyon, and disturbance of the highway and disposal of the rock would be serious obstacles. Construction may require temporary closing of 100- to 200-m (330- to 660-ft) sections of one traffic lane for operation of heavy machinery. Although NTPC proposes using rubber-tired equipment, resurfacing and repair of the lane may be necessary. Several talus slopes would present problems in stabilization, and only one or two of the constructed sections could be worked on at any one time. The only alternative to this special construction would be to cross the Clark Fork a total of four times, thus bypassing the constricted areas but considerably affecting the river.

Pipeline construction in the steep and narrow Siegel Creek Canyon would have to be done in the active streambed for possibly as much as 50 percent of the stream length. The alternative of ripping or blasting a sidehill cut along one side of the valley would cause problems with disposal of the cut spoil and stabilization of the numerous small chutes of talus. The stream could not be protected from sediment during construction. The most severe construction problems would be in the upper 6 km (4 mi) of the drainage, which is the narrowest and steepest part of the canyon.

Earthquake Hazards

NTPR crosses the Hope Fault several kilometers east of Thompson Falls. The fault is "potentially active" and poses little risk to the pipeline. Displacement of the surface has probably not occurred for the past 1.5 million years and there is no evidence of modern earthquake activity. NTPR parallels the Ninemile Fault within 3.3 km (2 mi) for approximately 75 km (46 mi); it lies within 0.5 km (0.3 mi) of the fault for approximately 16 km (10 mi) of the 75 km total. The Ninemile Fault has modern low-level earthquake activity, but has no known Recent (last ten thousand years) surface displacements. There is little risk to the pipeline, but field investigations of the areas where the fault is crossed by the route would provide information necessary for appropriate design or rerouting of the pipeline.

Geologic Concerns and Mineral Resource

Approximately 18 km (11 mi) of cliffs or steep rocky sideslopes are passed by NTPR. Potential landslide conditions occur along 0.5 km (0.3 mi) of the route, but most of these areas could be either bypassed during centerline selection or controlled by standard engineering techniques. The extensive cliffs and steep sideslopes are primarily in the narrow canyons of the Clark Fork and its tributaries. They are generally stable but would require considerable blasting and spoil disposal.

NTPR passes near an active antimony mine in Prospect Creek and areas of glacial till containing placer gold in the vicinity of Kennedy Creek in the Ninemile drainage northwest of Frenchtown. None of the mineral areas would be significantly affected by the pipeline.

There are many small slumps and landslides in the Ninemile drainage, particularly in the rocks that have been crushed and

broken by ancient movement on the Ninemile Fault. Those near the route are small and pose little risk to the pipeline (see chapter five, p. 42), even if set in motion by a large earthquake. No evidence of larger slumps or slides has been found, but it is often difficult to recognize them on densely forested steep slopes. If NTPR is selected, a careful search for larger slumps or slides in the rugged Siegel Pass, Prospect Creek, and Thompson Pass areas may be necessary.

The route closely passes several landslide areas in the hills north of Missoula. These slides may be active, but this has not been confirmed by detailed field work. Field studies in this area during the centerline survey would provide information necessary for appropriate design or rerouting of the pipe.

Impacts on Land Use: Legal Constraints

The only legal constraints NTPR encounters are zoning ordinances in Missoula County which would prohibit the pipeline in portions of Missoula County. According to the Missoula County Planning Board, the pipeline could not be granted a variance (Olsgaard 1979). However, other legal action—such as legislation—may allow a crossing.

Impacts on Land Use: Specially Managed Areas

This route crosses two areas (Patrick's Knob-North Cutoff and North Siegel) which were part of the RARE II study but which were not recommended for further study. Pipeline crossings may not, however, be compatible with management objectives; this would be determined by USFS.

Impacts on Land Use: Compatibility with Existing Corridors

NTPR would open up 56 km (35 mi) of new corridor primarily down the Ninemile Divide. Opportunities for right-of-way sharing exist along Prospect Creek and the Clark Fork.

Impacts on Land Use: Linear Patterns

There are eight paved road crossings and eighty unpaved road crossings on NTPR. Impacts would be negligible except, perhaps, for the Missoula area. This is the only route west of Bonner that crosses irrigation ditches.

Impact on Land Use: Site Patterns

NTPR goes through 1.9 km (1.2 mi) of urban and rural residential land and .6 km (.4 mi) of industrial area. Expansion of these land uses would be prohibited over the pipeline.

Impacts on Social and Economic Concerns

There would probably be a moderate impact on lodging facilities in Sanders County, as well as a potential lodging conflict between pipeline workers and summer tourists in Missoula. Land production lost during construction is estimated to be $14,800; permanent loss is estimated at $236,400. Reimbursement would have to be negotiated between NTPC and the land owner. Related employment in Montana would be an estimated eighty-nine person-years during the construction phase. Total estimated property taxes would be $41 million with straight-line depreciation over the life of the line and $79 million with constant appraised value assuming current average tax rates.

Impacts on Cultural Resources

Although sites are known to exist along this route, impacts cannot be determined until an intensive inventory, including subsurface testing, is completed prior to construction.

Impacts on Visual Quality

NTPR passes through 102 km (63 mi) where potential visual impact would be high along the permanently cleared right-of-way—most importantly, the upper Prospect Creek-Thompson Pass and the Siegel Creek-Upper Ninemile Creek areas. Should suspension bridges be used at any of the Clark Fork or Thompson River crossings, there would be high visual impact.

Impacts on Soils

One hundred twelve km (70 mi) of the total 177 km (110 mi) of NTPR passes through areas with high soil erosion potential. Most of these areas are in mountains, where there are steep slopes, a short growing season, and high annual precipitation relative to the drier valleys.

Impacts on Aquatic Life and Habitats

Most of NTPR follows the valleys of cold-water trout streams. These drainages contain both spring- and fall-spawning salmonid species; therefore, timing construction to avoid impacts would be difficult or impossible. All waterways crossed on this route have a DHES rating of $B\text{-}D_1$.

From the Idaho border to the mouth of the Flathead River, the Clark Fork has a DFWP ranking of only class 3, but has a large (greater than 566 m^3/s or 20,000 ft^3/s) mean annual discharge. The two proposed crossings of this stretch would be technically difficult, and construction-related impacts to aquatic life could be expected. Bank stabilization may also be a problem in this area. The route parallels the Clark Fork within 225 m (246 yd) for approximately 10 km (6 mi) in this section. A pump station would be required at either Plains or Paradise, depending on which eastern route is taken; construction at either site would increase the risk of oil contamination of the river.

Just south of Paradise, the Clark Fork becomes a class 2 stream, due in part to the presence of the rare westslope cutthroat trout (DFWP species of special concern). NTPR crosses this section of river and parallels it for approximately 4 km (2.5 mi) in the Quinn's Hot Springs region. A highway has already encroached upon the river in this area.

The Thompson River, a class 2 rainbow trout fishery, is also crossed by NTPR. One of the best fishing areas on the entire Clark Fork mainstem is immediately downstream from this crossing, at the mouth of the Thompson River.

Because of the narrow and steep-sided valleys of Prospect and Siegel creeks, NTPR traverses these streams several times and closely parallels them for most of their length. Impacts to aquatic habitats would be high because of bank and streambed disruption and removal of streamside vegetation. Both creeks support resident fisheries, and Prospect Creek is important as a spawning and nursery area for fish out of the Clark Fork and as a fishery to the people of Thompson Falls.

Sediments generated by construction along Prospect Creek, the Thompson River, and the Clark Fork would accumulate in Thompson Falls Reservoir and possibly harm the already limited fisheries there. The reservoir would ease oil-spill cleanup operations in this area.

The route crosses many small tributaries of Ninemile Creek that support associated aquatic life. Several have populations of westslope cutthroat. Although NTPR does not cross Ninemile Creek, generally staying within .8 km (.5 mi) of the stream, sediment would enter that creek from construction on tributaries. Oil spills on any of these tributaries would also be likely to reach Ninemile Creek. This drainage is important spawning habitat for fish from the Clark Fork.

On reentering the Clark Fork Valley, the route crosses many small tributaries, some of which have fisheries (e.g., Mill Creek, Grant Creek). Because of the low gradients and the irrigation-ditch networks in the flood plain, oil spills on most of these tributaries could be contained before reaching the Clark Fork. The route crosses Rattlesnake Creek, which provides some of Missoula's municipal water supply and is an important spawning stream for fish from the Clark Fork.

Impacts on Ground Water

NTPR crosses 29 km (18 mi) of land in ground-water risk category 5, and 88 km (55 mi) in category 4. The highest risk areas (category 5) are at major river crossings, and in the Missoula Valley. There are no category 3 areas along NTPR.

Impacts on Vegetation and Land Productivity

NTPR is predominantly forested and includes some highly productive habitat types (productivity ratings 1 and 2, table 33, p. 82) along upper Prospect Creek, the Clark Fork Valley, and the Siegel Pass area. Possible sharing of existing pipeline and powerline rights-of-way could reduce the actual amount of forest land taken out of production from Thompson Falls to Paradise. NTPR crosses the least amount of dry cropland.

Impacts on Wildlife and Habitats

Of all routes considered, NTPR traverses the most winter range and the greatest distance of severe winter concentrations of elk. NTPR crosses elk winter range from the mouth of Cooper Gulch into Prospect Creek to the Clark Fork crossing near Paradise. Some winter range is also crossed in the lower Ninemile drainage. The Clark Fork crossing near the mouth of the Thompson River would intrude upon an island which elk use both as winter range and as a calving site. The valleys and adjacent mountain slopes of Prospect Creek, the Clark Fork, and lower Ninemile Creek are also used as winter range by mule and white-tailed deer, and include some known severe winter concentration areas. An important bighorn sheep winter range (Brown 1975) is crossed near the mouth of the Thompson River. Of all routes west of Bonner, NTPR goes through the most deer winter range and the most white-tailed deer severe winter concentration area. Pipeline construction through these areas in late winter or early spring following a period of heavy snow cover would be detrimental to wintering herds; displacement and associated stress would likely cause increased over-winter mortality or decreased reproductive success.

Construction-related habitat alteration could reduce the amount of available forage along NTPR. This could be a short-term impact if the right-of-way was properly revegetated. Long-term displacement of animals from winter ranges would not likely occur, since existing roads or utilities are paralleled within 1 km (.6 mi) over most of NTPR's length.

Near Siegel Pass the route crosses forested roadless areas that are important summer security areas for elk. Since most of the surrounding areas have been logged and roaded, these few remaining security areas are highly important. The intrusion of a pipeline right-of-way and the associated increase in human use could adversely affect the elk herds through displacement and stress.

The Clark Fork Valley from Thompson Falls to Siegel Creek is historical peregrine falcon nesting habitat as well as probable nesting habitat for prairie falcons, golden eagles, ospreys, and bald eagles. Nearby construction-related disturbance could cause abandonment of active nests. A major effort to locate active raptor nests could be made during centerline selection to determine the extent of raptor use. Bald eagles also winter along the Clark Fork, often using trees along NTPR as perches.

The Ninemile Divide, while not formally classified as "critical" grizzly bear habitat, is considered important as a travel corridor for the bears because it connects two areas inhabited by grizzlies. Because of the low density of bears and the high degree of existing access, however, there would be little danger of conflict with grizzlies in this area.

NTPR also crosses more mountain grouse and waterfowl habitat than any other major route west of Bonner.

Impacts on Climate and Air Quality

Three PSD class 1 areas may be close enough to the route to be influenced by emissions from pipeline construction and operation. The Mission Mountains Wilderness and Selway-Bitterroot Wilderness are within 48 km (30 mi) of NTPR, and the Cabinet Mountains Wilderness is within 43 km (27 mi).

Missoula is the only area on NTPR with sufficient air quality data for accurate evaluation. This city does not meet state ambient air quality standards for carbon monoxide and TSP; thus, it has been designated a nonattainment area. A pulp and paper mill, two plywood plants, and a particle board plant are the major sources of emissions; in addition, there are a number of sawmills. Emissions from pipeline construction would further adversely impact the area's air quality.

No documented major emission sources are present on or near the remainder of NTPR. Outside of the Missoula Valley, the lower population density makes local emission sources less of a problem.

DNRC Modification Route

This route is identical to NTPR except in the following six areas where minor changes were made because of environmental or other considerations: (1) In lower Prospect Creek, a minor change was made below the mouth of Wilkes Creek to avoid multiple creek crossings and to more closely follow the existing road. (2) East of the Thompson River crossing, this route stays north of the Clark Fork and Highway 10-A for about 10 km (6 mi). It then crosses the river, joining NTPR where the river is much narrower and there are no islands. A steep cliff face is crossed by the route approximately 3 km (2 mi) east of Thompson River. (3) Just southeast of Siegel Pass, the DNRC Modification Route leaves NTPR for roughly 11 km (7 mi), going northeast of a heavily forested area which NTPR crosses, and follows the upper slopes of the bench through some heavily logged and roaded terrain, returning to NTPR near Marion Creek. (4) The DNRC Modification Route leaves NTPR at Kennedy Creek and, staying farther upslope from Ninemile Creek but remaining in the gently sloping bench, parallels NTPR for about 24 km (15 mi) northwest of Frenchtown. (5) From Frenchtown to Grant Creek just west of Missoula, the DNRC Modification Route parallels Interstate 90; it extends east from Grant Creek, crossing to rejoin NTPR at Rattlesnake Creek. (6) In the Pinegrove area east of Mount Jumbo, the DNRC Modification Route passes north of Pinegrove rather than south.

Terrain, Engineering, and Hydrologic Hazards

Besides the three problem areas also found on NTPR (see p. 125), the DNRC Modification Route passes through an additional area where pipeline construction would be difficult. Several kilometers east of the Thompson River the DNRC Modification Route passes through an area of steep cliffs and talus slopes. The route closely parallels Highway 200 and the Burlington Northern Railroad. In this constricted area, construction would be difficult and costly, and may temporarily interrupt highway and rail traffic. These construction problems, however, would not be as severe as those encountered in the Quinn's Hot Springs and Siegel Creek areas.

Earthquake Hazards

The DNRC Modification Route, like NTPR, crosses the Hope Fault several kilometers east of Thompson Falls and parallels the Ninemile Fault within 3.2 km (2 mi) for approximately 75 km (47 mi).

Geologic Concerns and Mineral Resources

In addition to hazards described for NTPR, potential landslide conditions occur along 1.4 km (.8 mi) of the DNRC Modification Route, primarily in the Tertiary sediments in the hills north of Missoula. Most of these areas could either be bypassed or controlled by standard engineering methods after being investigated for stability during centerline survey.

Impacts on Land Use: Legal Constraints

Legal constraints for the DNRC Modification Route are the same as those for NTPR (see p. 126.)

Impacts on Land Use: Specially Managed Areas

The DNRC Modification Route would cross the same specially-managed areas that NTPR crosses (see p. 126).

Impacts on Land Use: Compatibility with Existing Corridors

The DNRC Modification Route does not differ from NTPR with respect to corridors (see p. 126).

Impacts on Land Use: Linear Patterns

Although the DNRC Modification Route has the least number of paved road crossings of any of the routes west of Bonner, it in-

cludes the most unpaved road crossings. The majority of the unpaved road crossings would probably be trenched so the impacts should not be significant.

Impacts on Land Use: Site Patterns

Few residential or urban areas are crossed. This route crosses the greatest amount of industrial area of any of the routes, however, impacts would not be significant.

Impacts on Social and Economic Concerns

There may be a moderate lodging-facility shortage in Sanders County as well as a lodging conflict with summer tourists in Missoula. Land productivity lost would be an estimated $15,500 for the construction period, and $236,500 for the life of the line. Montana employment of this route would probably be eighty-nine person-years for the construction period. Estimated property tax revenue would be $42 to $82 million over the life of the project, assuming current tax rates.

Impacts on Cultural Resources

Impacts cannot be determined until an intensive inventory is done.

Impacts on Visual Quality

The DNRC Modification Route passes through approximately 10 km (6 mi) less than NTPR of land where visual impact would be high along the permanently cleared right-of-way. In addition to the upper Prospect Creek-Thompson Pass and the Siegel Creek-Upper Ninemile areas, this route goes along the narrow canyon following the Clark Fork between Thompson Falls and Plains. The route remains on the north side of the river and crosses a series of cliffs and steep talus slopes just above a paved highway and railroad grade. There, construction would involve extensive sidecuts and would lead to high visual impact.

Impacts on Soils

This route passes through approximately 114 km (71 mi) of mountainous terrain where the potential for soil erosion is high.

Impacts on Aquatic Life and Habitats

Impacts from this route would be similar to those from NTPR (see p. 126); however, Prospect Creek would be less disturbed because of the elimination of two crossings. The DNRC Modification Route crosses the Clark Fork at the narrowest channel instead of the island area. This might result in less instream disturbance and therefore fewer impacts to aquatic habitat; however, this requires further site-specific study and may be determined during centerline survey. By staying north of the Clark Fork west of the series of islands, the route is separated from the river by the highway. This decreases the probability of an oil spill reaching the river. Blasting would probably be required at the islands area, since the route is forced by rock cliffs to encroach on the river.

In the Ninemile Creek area, the DNRC Modification Route is generally farther from the main creek than NTPR, so there would be fewer direct impacts from oil spills and sedimentation. The total number of streams crossed by this route would be slightly less than NTPR; the number and siting of pump stations would be the same.

Impacts on Ground Water

The DNRC Modification Route crosses 17 km (11 mi) less land in ground-water risk category 5, and 7 km (4 mi) less land in category 4 than NTPR.

Impacts on Vegetation and Land Productivity

This route would affect more forested land than any other alternative west of Bonner, but fewer highly productive habitat types than would NTPR. Opportunities for right-of-way sharing along Prospect Creek and the Clark Fork are similar to those for NTPR (see p. 127).

Impacts on Wildlife and Habitats

This route differs from NTPR with respect to potential wildlife impacts in three important areas: (1) the DNRC Modification Route just east of the Thompson River traverses considerably more bighorn sheep severe winter concentration areas but avoids much of the deer and elk winter range (including some severe winter concentration areas) along the south bank of the Clark Fork and along Eddy Creek; (2) some of the roadless habitats and elk summer security areas near the head of Ninemile Creek are avoided by following existing logging roads and clearcuts; and (3) possible construction-related impacts to deer wintering in the foothills are avoided by closely paralleling the interstate highway from Frenchtown to Missoula (near Grant Creek).

Impacts on Climate and Air Quality

Impacts on climate and air quality do not differ from NTPR (see p. 127).

Arlee Route

This route was originally identified by NTPC as an alternative; it was dropped because the tribal council of the Confederated Salish-Kootenai Tribes has refused to allow construction across the reservation. It is included in this discussion because a route across the reservation would be an alternative to the severe terrain encountered in the Knox Pass-St. Regis and the Paradise-Siegel Creek-Ninemile Creek areas. West of Weeksville, it is identical to NTPR; east of this point it generally proceeds southeast to Perma. After crossing the Flathead River, the Arlee Route parallels the south bank of the river along the Yellowstone Pipeline right-of-way to Dixon. It then proceeds southeastwardly, roughly following U.S. 93 to Missoula, where it joins NTPR.

Terrain, Engineering, and Hydrologic Constraints

The Arlee Route has four major (<3,000 ft^3/s or 85 m^3/s) river crossings. In addition to probable construction difficulty along Prospect Creek, construction would be difficult down a short, steep section south of Evaro Pass where the route drops down into the Missoula Valley; however, this would present no major construction hindrance.

Earthquake Hazards

For roughly 20 km (12 mi), the Arlee Route parallels but does not cross the St. Mary's Fault. The fault is seismically active, but no Recent (last ten thousand years) surface displacements are known. The Arlee Route also closely parallels, but doesn't cross, the Jocko Fault which forms the bold mountain front along the southeast side of the Jocko Valley. Although evidence is inconclusive, the fault is not currently known to be seismically active. These two faults would pose little hazard to the pipeline. Field investigation could determine the appropriate pipeline design if the route is changed to cross directly over either of the faults.

Geologic Concerns and Mineral Resources

Only 1 km (.6 mi) of cliffs and steep sideslopes lie along the Arlee Route. There are 0.8 km (0.5 mi) with potential landslides, which generally could be bypassed or controlled. Overall, the Arlee Route has few geologic hazards.

Impacts on Land Use: Legal Constraints

The Confederated Salish-Kootenai Tribal Council has twice refused permission for the proposed pipeline crossing.

Impacts on Land Use: Specially Managed Areas

The Arlee Route does not cross any specially managed areas.

Impacts on Land Use: Compatibility with Existing Corridors

Existing corridors could be used for all but 33 km (20.5 mi) of this route.

Impacts on Land Use: Linear Patterns.

Along the Arlee Route, seven paved roads and seventy-seven unpaved roads are crossed. There would be no significant impact.

Impacts on Land Use: Site Patterns

Of all routes west of Bonner, the Arlee Route would affect the least amount (approximately 1 km or .6 mi) of urban, residential, and industrial lands. Impacts would be negligible.

Impacts on Social and Economic Concerns

A moderate impact on lodging facilities would probably occur in Sanders County, and there may be a potential lodging conflict with summer tourists in Missoula. Land productivity lost would be approximately $22,200 for the construction period and $153,000 over the life of the project. Montana employment during construction of the Arlee Route would be about eighty-nine person-years, while estimated property taxes would be $45 to $94 million for the life of the line, assuming current tax rates.

Impacts on Cultural Resources

Specific impacts cannot be determined until an intensive inventory is done.

Impacts on Visual Quality

The Arlee Route crosses 103 km (64 mi) of areas with high potential visual impact, including the upper Prospect Creek-Thompson Pass area and the Evaro Pass area (between Arlee and Missoula). Should suspension bridges be used at any of the river crossings visual impacts would be high.

Impacts on Soil

This route passes through about 100 km (62 mi) of primarily mountainous terrain with high erosion potential.

Impacts on Aquatic Life and Habitats

The information on aquatic habitats for the portion of this route crossing the Flathead Indian Reservation is not directly comparable to the data for the other routes. Reservation streams have not been ranked by DFWP and were therefore subjectively put in classes with similar streams that had been ranked. Based on these rankings and on the numbers of streams crossed or paralleled, the Arlee Route would have fewer impacts on aquatic life and habitats than would the others. It would have less impact on the Clark Fork than either NTPR or the DNRC Modification Route because it avoids the Quinn's Hot Springs area

The Arlee Route crosses and closely parallels the Flathead River at a section greater than 280 m^3/s or 10,000 ft^3/s mean annual discharge. The river is subjectively ranked as class 3. This would be the major impact to aquatic resources on the reservation. Four tributaries of the Jocko would be crossed, and impacts to that stream are possible. The Arlee Route does not avoid crossing Rattlesnake Creek, but it crosses fewer high gradient streams than any other western route.

Impacts on Ground Water

The Arlee Route crosses 16 km (10 mi) of land in ground-water risk category 5, and 78 km (48 mi) in category 4.

Impacts on Vegetation and Land Productivity

Considerably less forest land, as well as fewer highly productive habitat types, would be affected by the Arlee Route than by the other possible routes west of Bonner. The amount of forested land actually taken out of production could be reduced by sharing existing rights-of-way along Prospect Creek and the Clark Fork, as well as near Evaro. The Arlee Route would cross the greatest amount of irrigated cropland and total cultivated land.

Impacts on Wildlife and Habitats

Although the available information is limited, the Arlee Route appears to traverse more moose and pronghorn winter range than the other routes west of Bonner. A great blue heron rookery is approached near Perma, and grizzly bear habitat is crossed near Evaro.

Impacts on Climate and Air Quality

Possible impacts on air quality are the same as for other routes west of Bonner (see p. 127).

Knox Pass Route

This route follows NTPR from Thompson Pass down Prospect Creek, branching off 3.2 km (2 mi) southwest of Thompson Falls. Following Dry Creek and Knox Creek to Knox Pass, elevation 1,569 m (5,148 ft), the route goes south along Twelvemile Creek, following north of Boyd Mountain into St. Regis. East of St. Regis, this route parallels Interstate 90 to Frenchtown, then joins NTPR. The Clark Fork is crossed in three places: once at St. Regis and twice between Tarkio and Alberton. Over most of this route, pipeline construction could be done adjacent to Interstate 90 or the interstate frontage road. The terrain is steep in several areas along the Clark Fork Canyon, and expensive construction techniques and perhaps additional Clark Fork crossings would be needed. Terrain is particularly confining along Twelvemile Creek, which would probably have to be crossed several times.

Terrain, Engineering, and Hydrologic Constraints

Each crossing of the Clark Fork along the route would be major (<3,000 ft^3/s or 85 m^3/s); however, the difficulty would generally be less than those crossings upstream of Thompson Falls on NTPR and the DNRC Modification Route. There would be inadequate construction room around Keystone and Pardee creeks where extensive cuts into steep mountainsides would be required. Stability would probably not be a problem, but highway and railroad traffic would be disturbed and cut spoil would have to be disposed. There are several other narrow sections of canyon requiring a total of approximately 5.6 km (3.5 mi) of extensive rock cutting. Most of this work would require blasting, and disposal of overburden would be a problem. Eastward from Superior, along the St. Regis River and the Clark Fork to the vicinity of Frenchtown, carefull centerline selection would be needed to minimize river crossings and rock work.

There would be no severe hindrances to construction on Knox Pass; however, the approaches to the pass are through narrow valleys, where there would be some major unavoidable construction problems. Overall, there are no stretches where construction would not be feasible. Construction across Knox Pass would be roughly comparable to crossing Siegel Creek and Siegel Pass on NTPR and the DNRC Modification Route.

Earthquake Hazards

For approximately 20 km (12 mi), the Knox Pass Route runs parallel to and just north of the Osburn Fault, which follows the valley of the St. Regis River. The fault is apparently not seismically active, but evidence is sparse and inconclusive. It probably would pose little risk to the pipeline, but could be field-checked if the route were to be changed to cross the fault.

Geologic Concerns and Mineral Resources

The Knox Pass Route passes through approximately 7 km (4.4 mi) of cliffs on steep, rocky sideslopes. These are primarily along the narrow valley of the St. Regis River, along the Clark Fork, and in short stretches by Knox and Twelvemile creeks. Cliffs and slopes are generally stable but, as on other routes, would require considerable blasting and spoil disposal.

Potential landslide conditions lie along 0.8 km (0.5 mi) of the route, but could probably be bypassed or controlled. If the Knox Pass Route is chosen, a careful search for large landslides and slumps in the steep forested mountain slopes along Dry and Knox creeks would be necessary.

Impacts on Land Use: Legal Constraints

There are no legal constraints encountered by the Knox Pass Route.

Impacts on Land Use: Specially Managed Areas

The Cherry Peak RARE II study area which can be crossed by pipelines, lies along the Knox Pass Route. The Alberton water supply and the Alberton Recreation Area also lie along the route, but could be avoided by centerline adjustment.

Impacts on Land Use: Compatibility with Existing Corridors

A new right-of-way of 60 km (38 mi) would have to be cleared from Thompson Falls to St. Regis. Existing rights-of-way could then be used.

Impacts on Land Use: Linear Patterns

The Knox Pass Route crosses eleven paved roads, and seventy-five unpaved roads. The total impact would be negligible.

Impacts on Land Use: Site Patterns

Eight km (5 mi) ot urban and residential lands and less than 1 km (0.6 mi) of industrial areas would be aftected by the Knox Pass Route. The impacts would not be signiticant.

Impacts on Social and Economic Concerns

In addition to impacts on lodging facilities in Sanders and Missoula counties, adverse impact to the commercial sector ot Superior could be expected it the route proceeds through the downtown business district. This could be avoided by centerline adjustment.

Land productivity lost would be an estimated $17,900 during the construction period, and $259,000 over the twenty-year operational period. Estimated Montana employment would be eighty-nine person-years during construction. Assuming current tax rates, estimated property tax revenues for the Knox Pass Route would be $67 to $131 million over twenty years.

Impacts on Cultural Resources

Specific impacts cannot be determined until an intensive inventory is done.

Impacts on Visual Quality

The Knox Pass Route goes through 103 km (64 mi) of areas with high potential visual impact, including the upper Prospect Creek-Thompson Pass areas, the section between Prospect Creek and St. Regis (crossing Knox Pass), and torested areas along the Clark Fork between St. Regis and Frenchtown.

Impacts on Soil

Most of the Knox Pass Route passes through mountainous areas with high soil erosion potential—114 km (71 mi) out of a total distance of 188 km (117 mi).

Impacts on Aquatic Life and Habitats

There would be greater impacts on aquatic life on the Knox Pass Route than on any other western alternative. The route is contined to narrow mountain stream valleys from the Idaho border to St. Regis. This route requires a pump station on Prospect Creek, thereby increasing the risk of oil contamination ot the creek and the Clark Fork, which is downstream. Twelvemile Creek in the St. Regis drainage would be encroached upon and crossed several times. Impacts would be high on this popular fishing stream, which is an important spawning and rearing habitat for trout of the St. Regis River. The route also encroaches on Dry Creek, Knox Creek, and Mullan Gulch; these are not considered sport fisheries (although they may provide some spawning and rearing habitat), but would provide channels for oil to reach major drainages. The Knox Pass Route also crosses the St. Regis River (class 2), which receives spawning migrations out of the Clark Fork, is heavily fished, and has good trout populations.

The route crosses the Clark Fork three times and parallels the river within 225 m (246 yd) for a distance of 23 km (14 mi) where it is a class 2 fishery. A pump station on the river near Alberton would be required for this route. Construction-related impacts to the Clark Fork and potential impacts from oil spills would be high. Ninemile and Rattlesnake creeks would be crossed by the Knox Pass Route, which crosses more high-gradient (over 8 percent) streams than any other route.

Impacts on Ground Water

The Knox Pass Route crosses 24 km (15 mi) ot land in ground-water risk category 5 and 80 km (50 mi) in category 4. The route closely passes four towns which get part or all of their water supply from ground water.

Impacts on Vegetation and Land Productivity

Nearly the entire length ot the Knox Pass Route goes through forested land. This route crosses not only the most dry cropland and the least amount ot irrigated cropland of all the western routes, but also the largest amount of productive timberland. A new right-ot-way would have to be cleared from Thompson Falls to St. Regis which includes highly productive timberland on both sides of Knox Pass.

Impacts on Wildlife and Habitat

The route traverses habitats similar to those crossed by NTPR, although no roadless security areas—such as Siegel Pass—are encountered along the Knox Pass Route. The route crosses no occupied bighorn sheep habitat, and traverses the least deer winter range and mule deer severe winter concentration areas of all other routes.

Impacts on Climate and Air Quality

Potential impacts on air quality are the same as those discussed for other routes (see p. 127).

ROUTES EAST OF BONNER

NTPR

Beginning at Bonner, NTPR follows the abandoned Milwaukee Railroad right-ot-way north of the Blackfoot river to the McNamara Bridge, where the river is crossed. It continues southwest along a MPC 161-kV transmission line near the Copper Clitf mine south of Potomac, proceeds eastward over the Garnet Mountains, crossing a high ridge at 2,010 m (6,590 ft), and follows the Douglas Creek drainage to the Nevada Creek Valley south of Helmville. The route continues southeastward, crosses the Continental Divide near Greenhorn Mountain attaining an elevation of 1,980 m (6,500 ft), follows Sevenmile Creek from Birdseye to Helena, and crosses the Helena Valley by paralleling Custer Avenue through Helena. It then follows Highway 12, crossing the Missouri River just downstream trom Townsend. NTPR crosses the Big Belt Divide, elevation 1,950 m (6,400 ft), to Ringling via the Dry Creek Ridge Road. It then proceeds northeast to North Dakota via Martinsdale, Flatwillow, Mosby, and Bainville, crossing the Missouri River a second time near Bainville before entering North Dakota. The North Fork of the Musselshell River is crossed near Lennep. The Musselshell River is crossed at Mosby, and the C.M. Russell National Wildlife Range is closely skirted at Big Dry Creek.

Terrain, Engineering, and Hydrologic Constraints

There are three problem areas along this route. The only feasible route up the narrow canyon of the Blackfoot River is along the railroad grade, which is currently not in use tor rail traffic. Even using the existing railroad right-of-way construction would be slow and costly, and would require blasting ot rock cuts over a distance ot approximately 50 km (30 mi).

The eastern part ot the Garnet Range has rough terrain, hard rock, and high relief. Access would be difficult and construction progress slow, particularly in the headwaters of Bear Creek (north and northwest ot Drummond).

The Missouri River crossings at Townsend and Bainville could be done by conventional trenching or bridging, with no obvious engineering problems. Directional drilling may be possible at these crossings.

Earthquake Hazards

NTPR passes through three areas of known modern seismicity where tield work would be necessary tor design modifications of the pipe and above-ground structures. In the Helmville-Nevada Valley area, the prominent scarp of the Helmville Fault forms the northeast boundary of the Garnet Range and the southwest boundary of the Avon Valley. The Avon Valley Fault forms the northeast side of the valley. There is both historical and modern seismicity but, as yet, there is no firm evidence of Recent (last ten thousand years) surface displacements. Ridges near the south end of Nevada Lake have been observed (NTPC 1979), possibly indicating an unmapped tault of Recent age (last ten thousand years). The Nevada Valley area in general is seismically active. If faults that could

directly offset the pipe were located during centerline selection, the design and siting of the pipe and necessary pump station could be done with full consideration of seismic hazard (see further discussion in chapter five).

Recent mapping (USDI 1977) has tentatively identified the Prickley Pear Fault in bedrock northwest and southeast of Helena. There is no surface evidence of the fault in the Helena Valley; the fault underlies and is masked by stream sediments. No detailed geophysical studies have been made to locate the fault. On map 3, p. 44, the Prickley Pear Fault is mapped with a dashed line to show that its location is not exactly known. NTPR parallels this fault (as imprecisely mapped) within 1 km (0.6 mi), for approximately 10 km (6 mi). A number of southeast-trending faults southeast of Helena are also shown in map 3. There is little published information on them.

North of Helena, the Scratchgravel Hills area is seismically active. The Scratchgravel Hills Fault, however, shows no evidence of Recent (last ten thousand years) surface displacement.

Detailed geologic surveys throughout the Helena area if made during the centerline and trenching phases of the project, would give more concrete evidence of the probability for surface offsets along faults which cross the pipeline route. If such studies show evidence for Recent fault offsets at the level of the pipe trench, the trench design could be modified or possible reroutes be considered. Reroutes to avoid the general vicinity of the Prickley Pear Fault would not be needed unless actual evidence for Recent offsets by faulting is found.

A northwest-trending zone of faults (see map 3) extends from Deep Creek (Fault #41) southward to Sixmile Creek (Fault #40) in the Townsend area. The age of most recent movement is younger than two million years. The Clarkston Valley Fault (#39) is also younger than two million years (Pardee 1926, 1950) and is in the vicinity of the 1925 Clarkston earthquake (magnitude 6.75). Microearthquake surveys show that this fault is very active today (Oamar and Hawley 1979).

NTPR crosses fault #41 southeast of Townsend (map 3). This fault may be seismically active today, but evidence for this is questionable because many earthquakes recorded in the Townsend Valley may be mislocated (Qamar and Hawley 1979). Robinson (1959) found no evidence of Recent movement along the fault.

The Townsend area is active seismically. Geologic field studies would be necessary to determine the need for changes in pipe design or routing.

Geologic Concerns and Mineral Resources

There are 3 km (2 mi) of cliffs and steep sideslopes on this route, almost all in the 10-km (6-mi) section paralleling the Blackfoot River and in the headwaters of Bear Gulch in the Garnet Range. No potential landslide or slump areas were identified. The route crosses a total of 50 km (31 mi) where hard bedrock would require blasting to excavate the pipe trench.

Impacts on Land Use: Legal Constraints

The only potential legal constraints on NTPR are special-zoning districts within Lewis and Clark County. NTPR may be able to get a variance or avoid them by centerline adjustment.

Impacts on Land Use: Specially Managed Areas

The route crosses several specially managed areas, including BLM wilderness-study areas which have been eliminated from the BLM study; consequently, the areas involved can be crossed by pipelines. The Canyon Ferry Wildlife Management Area and the Fort Harrison Entrance SCS Near-Pristine Area are both along this route; right-of-way easements could be granted for these areas. NTPR crosses the Lewis and Clark fairgrounds but they could be avoided by centeline adjustment.

Impacts on Land Use: Compatibility with Existing Corridors

This route would use approximately 189 km (118 mi) of existing corridor.

Impacts on Land Use: Linear

Seventeen-paved and 142-unpaved road crossings would be necessary on NTPR. Impacts would probably be negligible, except in the Helena area. Fifteen irrigation ditches are also crossed.

Impacts on Land Use: Site Patterns

No industrial areas and only 1.3 km (0.8 mi) of urban area are crossed by NTPR. Future housing expansion would be limited on the 10 km (6 mi) of residential land crossed by this route.

Impacts on Social and Economic Concerns

When construction takes place out of Helena's commuting zone significant lodging shortages would occur. Lodging facilities is Sidney, Fairview, Wolf Point, and, to some extent, Glendive are presently occupied by workers associated with oil and gas exploration, drilling, and collector/line construction. Lodging in these communities will continue to be in short supply. During pipeline construction, monthly lodging shortages are estimated to range from 23 to 416 units. While NTPC does not plan to use construction camps, a camp capable of lodging 390 to 450 persons may be appropriate mitigation for pipeline workers in both central and eastern Montana. A smaller camp capable of loding thirty to eighty workers may be necessary during construction of fixed-site facilities in eastern Montana. Optional small camps, capable of lodging thirty workers, could be considered for the advance pipeline construction crews (see **Northern Tier Report No.** 6).

Land productivity lost between Bonner and the North Dakota line would be an estimated $163,500 during the construction period and $148,200 for the project life. Estimated Montana employment would be 292 person-years during construction, and there would be about 120 direct and induced jobs, with fifty-seven going to Montanans, during the twenty-year operating phase. Projected property tax revenues would be $128 to $250 million over twenty years.

Impacts on Cultural Resources

Impacts will not be known until an intensive inventory is done.

Impacts on Visual Quality

The primary potential visual impact areas along NTPR would be in the forested areas of the Garnet Range, the Continental Divide (west of Helena), and the Big Belt Mountains. The total distance across areas of high potential visual impact is 82 km (51 mi).

Impacts on Soil

NTPR crosses approximately 163 km (101 mi) of land with high erosion potential, out of a total distance of 827 km (514 mi). Erosion rates would be particularly high in local badland areas on the plains, and on steep slopes in the mountains.

Impacts on Aquatic Life and Habitats

NTPR closely parallels the Blackfoot River for approximately 15 km (9 mi), crossing it once. This section of river is a class 1 stream containing westslope cutthroat, and construction activity in and along the river would harm aquatic life. Sediment from construction would accumulate in the reservoir at Milltown. If an oil spill occurred, the reservoir would ease cleanup.

NTPR crosses many small streams, most of them tributaries to Nevada Creek. Several, like Douglas Creek, are class 4 streams. Impacts to Sevenmile Creek near Helena would be high—the route crosses the creek three times and closely parallels it for 5 km (3 mi).

The Missouri River is crossed by NTPR just upstream from Canyon Ferry Reservoir and again near the North Dakota border. Both of these river sections support class 1 fisheries. Paddlefish and pallid sturgeon, species of special concern in Montana as defined by DFWP, are present in the river near the North Dakota border. Near Canyon Ferry, the Missouri River is a trout fishery, and Canyon Ferry Reservoir is a productive impoundment. Spawning runs of brown trout (fall spawners) and rainbow trout (spring spawners) out of Canyon Ferry are important to the maintenance of fish populations in this area. If the Missouri crossings were aerial or directionally drilled crossings; the overall impacts to aquatic resources would be greatly reduced.

Other high-quality fish streams crossed by NTPR include the North Fork of the Musselshell River near Lennep and the Musselshell River near Mosby. The North Fork has good trout populations, while the Musselshell near Mosby is a good warm-water fishery particularly for sauger and channel catfish. The route could also affect the Little Blackfoot (class 3) because a pump station would be required on North Trout Creek, a tributary of the Little Blackfoot.

Several tributaries of the Fort Peck Reservoir are crossed, so this unique impoundment could be contaminated by an oil spill within these drainage basins. The Big Dry Creek crossing, which is the crossing nearest to Fort Peck, would be particularly important in this regard, as a pump station would be located there.

There are creek chub present near the proposed site of the Redwater Creek crossing. This species is rare in Montana and of special concern. Redwater Creek is also of local importance because running water is scarce in that region.

Impacts on Ground Water

NTPR crosses 27 km (17 mi) of land in ground-water risk category 5, 86 km (54 mi) in category 4, and 85 km (53 mi) in category 3, out of a total of 827 km (514 mi). The primary category 5 areas (highest-risk) are at the crossing of the Missouri River near the North Dakota border, the Helena Valley, and a short segment near Nevada Lake.

Impacts on Vegetation and Land Productivity

Of all eastern alternatives, NTPR would cross the greatest amount of forested land and the least amount of total cropland. Use of existing railroad or powerline rights-of-way could reduce the amount of timber land taken out of production from Bonner to the Garnet area.

Impacts on Wildlife and Habitats

NTPR traverses a great variety of productive wildlife habitat, and construction along this route could adversely affect many species. NTPR crosses severe winter concentration areas of elk west of Martinsdale; of mule deer between Lennep and Martinsdale, and north of Richey; of white-tailed deer near Martinsdale; and of pronghorn along Flatwillow Creek, southeast of Vida, and along Charlie Creek north of Lambert. Of all eastern alternatives, NTPR crosses the most elk winter range and mule deer severe winter range. Golden eagle nesting areas are approached near Lennep, Loweth, and Martinsdale, and osprey nest sites are located along the route near Nevada Lake and Townsend. A large nesting colony of great blue herons and double-crested cormorants is closely approached near Townsend, and a smaller great blue heron colony is crossed near Flatwillow. Sage grouse strutting grounds and sharp-tailed grouse dancing ground are known to be within 1 km (0.6 mi) of the route north of Ringling, near Living Springs, and along Nelson Creek. NTPR crosses the least amount of ring-necked pheasant habitat of all alternatives. Prairie dog towns are found near the Big Dry, Nelson, and Timber creek crossings. While no conclusive evidence has been discovered, it is possible that black-footed ferrets may be found in these areas.

Impacts on Climate and Air Quality

Northwest of Helena lies the Gates of the Mountains Wilderness, a PSD class I area. The U.L. Bend National Wildlife Refuge and Medicine Lake National Wildlife Refuge are other PSD class I areas within 48 km (30 mi) of the route. Pollutant levels are monitored by the Air Quality Bureau of DHES only at Helena and Circle. Portions of the Helena Valley have been designated nonattainment for TSP and sulfur dioxide.

In the Helena area, a lead smelter is a major emission source. Other point sources include a cement plant in Montana City (south of Helena) and a small lumber mill in Townsend. Air quality is considered good along the remainder of this route, which lacks population centers or industrial sources. With the exception of the Helena Valley, population-related area sources (e.g., motor vehicle emissions) can be expected to be minimal. Other area sources vary depending on agricultural practices, land use, unpaved roads, and other site-specific concerns.

DNRC Modification Route

This route is identical to NTPR except for the following three changes: (1) The route diverges from NTPR near the Copper Cliff Mine, south of Potomac, following the MPC 161-kV transmission line to the head of Ten Mile Creek. It then follows Ten Mile Creek to Bearmouth, where it crosses the Clark Fork. The route continues east to Avon along the Yellowstone Pipeline right-of-way crossing the Clark Fork again between Garrison and Gold Creek. It joins NTPR 8 km (5 mi) north of Avon. (2) A minor adjustment from Flatwillow Creek to Big Dry Creek moves the route approximately 1.6 km (1 mi) to the north, bringing it closer to Highway 200 and avoiding some heavily dissected terrain. (3) DNRC's Modification Route leaves NTPR 19 km (12 mi) east of Jordan, and parallels Highway 200 past Circle and Richey. It leaves the highway near Richey and continues northeastward to rejoin NTPR 5 km (3 mi) north of Girard. Although 2.6 km (1.6 mi) longer than the corresponding NTPR segement, this modification has certain advantages over the proposed route: there would be easier access to the right-of-way because it parallels Highway 200 over most of its length; it crosses fewer kilometers of pronghorn and mule deer severe winter concentration areas; it has lower erosion hazard and avoids the rough badlands and steep coulees crossed by NTPR; and it avoids five BLM preliminary wilderness study areas which are crossed by NTPR (Nelson Creek, Hagen Gap, Woody Flat, Big Dry Arm, and Dry Creek-Timber Creek Divide), three of which have been recommended for further study. The disadvantages of the DNRC Modification Route include that it crosses coal fields that may be mined and it parallels the Redwater Creek for several kilometers.

Terrain, Engineering, and Hydrologic Constraints

In addition to the construction difficulties also found on NTPR in the canyon of the Blackfoot River, the steep canyon walls of Bear Gulch in the Garnet Range would severely hinder construction for approximately 0.6 km (1 mi). Sidecuts in rock would be required and work vehicles would have only one traffic lane. DNRC considers that cliffs located in the northwest section of the drainage could be avoided during centerline selection. However, NTPC maintains that the route would have to go over these cliffs and therefore is not feasible considering engineering difficulties and cost.

Earthquake Hazards

The DNRC Modification Route crosses the same faults as does NTPR (see p. 130).

Geologic Concerns and Mineral Resources

These are similar to those found on NTPR. This route also crossess strippable lignite in McCone county (see p. 131).

Impacts on Land Use: Legal Constraints

As on NTPR, Lewis and Clark county special-zoning districts are the only potential legal constraint on this route.

Impacts on Land Use: Specially Managed Areas

The DNRC Modification Route crosses the same specially managed areas as does NTPR (see p. 131).

Impacts on Land Use: Compatibility with Existing Corridors

The DNRC Modification Route includes 303 km (188 mi) of existing corridor.

Impacts on Land Use: Linear

There are 22 paved and 158 unpaved road crossings along this route. Impacts would probably be negligible, except in the Helena area. The route also crosses 15 irrigation ditches.

Impacts on Land Use: Site Patterns

The DNRC Modification Route crosses the same urban and residential areas as NTPR (see p. 131).

Impacts on Social and Economic Concerns

Potential impact from the DNRC Modification Route does not significantly differ from NTPR (see p. 131).

Impacts on Cultural Resources

Impacts will not be known until an invensive inventory is done.

Impacts on Visual Quality

The DNRC Modification Route crosses the same potential high visual impact risk areas as does NTPR (see p. 131).

Impacts on Soils

The DNRC Modification Route crosses about 181 km (113 mi) of land with high erosion potential, out of a total distance of 835 km (519 mi) which is comparable to NTPR.

Impacts on Aquatic Life and Habitats

Impacts on the Blackfoot River and the Missouri River from this route would be the same as from NTPR. The DNRC Modification Route also crosses back into the Clark Fork Valley and crosses the Clark Fork twice, where it is a class 2 fishery. The DNRC Modification Route also crosses the Little Blackfoot River twice and Flint Creek once; both of these are moderate-sized (over 3 m^3/s or 100 ft^3/s mean annual discharge), class 3 fisheries. This section of the route would have more severe impacts on aquatic life than would NTPR, which only crosses some small tributaries of Nevada Creek in this area.

In the Circle region, the DNRC Modification Route crosses many more small intermittent tributaries of Redwater Creek than does NTPR. Unlike NTPR, however, the route crosses the creek where there is no suspected presence of creek chub. Impacts along the rest of this route would be the same as along NTPR; pump station locations would not differ.

Impacts on Ground Water

The DNRC Modification Route crosses 30 km (19 mi) of land in ground-water risk category 5 (highest risk), 198 km (123 mi) in category 4, and 81 km (50 mi) in category 3, out of a total of 835 km (519 mi).

Impacts on Vegetation and Land Productivity

By avoiding extensively timbered areas in the Garnet Range east of Garnet, the DNRC Modification Route would have less impact on timber productivity than would NTPR; in fact, it crosses the least amount of timberland of all eastern alternatives. This route goes over the greatest amount of irrigated cropland, with NTPR crossing almost as much.

Impacts on Wildlife and Habitats

Between Mosby and Sand Springs, the DNRC Modification Route crosses a pronghorn severe winter concentration area which is avoided by NTPR. In the Jordan-North Dakota segment, the DNRC Modification Route crosses more pronghorn winter range, but less pronghorn severe winter concentration area and less mule deer severe winter concentration area than does NTPR. Between Bearmouth and Helena, less elk winter range is crossed by this route than by NTPR.

Impacts on Climate and Air Quality

Impacts on climate and air quality are the same as those discussed for NTPR (see p. 132).

Hi-Line Route

From Bonner to the McNamara Bridge near Potomac, this route is identical to NTPR. Near Twin Creeks it goes north, crossing two unnamed passes, with elevations of 1,695 m (5,560 ft) and 1,615 m (5,300 ft), into the Blanchard Creek Drainage. It then extends eastward, following Blanchard Creek to Clearwater Junction, crossing the Clearwater River en route. East from Clearwater Junction, the route roughly parallels Highway 200 north past Ovando and Lincoln, crossing the Continental Divide 3.2 km (2 mi) northwest of Rogers Pass at 1,850 m (6,080 ft). It then extends northeast to Havre, passing between Square Butte and Shaw Butte, crossing the Sun River west of Great Falls, and roughly paralleling Highway 87 from Great Falls to Havre. After crossing the Milk River west of Havre, the route proceeds almost due east 0.8 km (0.5 mi) north of the Fort Peck Indian Reservation, entering North Dakota east of Dagmar. Montana's route was restricted to entering North Dakota within the corridor boundaries of NTPC's North Dakota application.

Terrain, Engineering, and Hydrologic Constraints

Construction up the narrow canyon of the Blackfoot River would be as described for NTPR (see p. 130). The Hi-Line Route then follows Cadotte Creek to a pass approximately 3.2 km (2 mi) northwest of Rogers Pass, and follows a ridge down the Dearborn Valley. The terrain is steep and rugged and would involve considerable rock ditching; but there are no insurmountable obstacles. There may be construction difficulties in the Blackfoot River Valley above Lincoln where the route crosses a low, broad, and wet floodplain. Special construction techniques to minimize aquatic and wildlife impacts may be required. Centerline adjustment may avoid most of the wet areas.

Earthquake Hazards

From where it diverges from NTPR eastward to the mountain front near Rogers Pass (approximately 110 km or 68 mi), the Hi-Line Route passes through an area of active seismicity, with risk of major earthquakes. East of the mountains the seismic risk is negligible.

North of Helmville, the Hi-Line Route crosses the St. Mary's Fault which is now seismically active. The Hi-Line Route also crosses Fault #129, (map 3), which runs along the mountain front of the northeast edge of Lincoln Valley; it may be seismically active, but evidence for this is inconclusive. If the Hi-Line Route is selected, these areas would merit further field investigations before pipeline construction.

Geologic Concerns and Mineral Resources

Almost all geologic hazards are found in the 10-km (6-mi) section paralleling the Blackfoot River just east of Bonner, near the Continental Divide east of Lincoln, and in the hilly terrain just west of Lincoln. The route crosses strippable lignite in Roosevelt County.

Impacts on Land Use: Legal Constraints

The only potential legal constraints on the Hi-Line Route are near Havre, which has zoning ordinances. These may be avoided by centerline adjustment or variances may be granted.

Impacts on Land Use: Specially Managed Areas

This route crosses several specially managed areas (see table 42), the majority of which cannot be crossed by a pipeline without Congressional or Presidential action. It is possible to avoid some of these areas by adjusting the centerline. The BLM wilderness study areas may allow pipeline crossings in the near future.

Impacts on Land Use: Compatibility with Existing Corridors

The Hi-Line Route includes existing corridors for about half its length.

Impacts on Land Use: Linear Patterns

There would be 25 paved and 275 unpaved road crossings on the Hi-Line Route; however, impacts would be negligible. This is the only route east of Bonner that does not cross any irrigation ditches.

Impacts on Land Use: Site Patterns

Only 3 km (1.9 mi) of industrial, urban, and residential land are along the Hi-Line Route. Impacts would be negligible.

Impacts on Social and Economic Concerns

Lodging impacts are generally similar for the Hi-Line Route as for NTPR (see p. 131); in addition, Great Falls, Havre, and Glasgow would be impacted as commuting centers. Problems may occur in Havre and Plentywood, where Canadian commercial trade may be affected.

Land productivity lost would be an estimated \$221,500 during pipeline construction and \$152,300 during pipeline operation. Montana construction employment for the route would be an estimated 286 person-years; there would be a total of 118 direct and induced

jobs during the operational life of the project with fifty-seven going to Montanans. Estimated property tax revenues for the life of the project would be $176 to $361 million.

Impacts on Cultural Resources

Impacts cannot be determined until an intensive inventory is done.

Impacts on Visual Quality

The Hi-Line Route goes through 84 km (52 mi) of mountainous area with high potential visual impact, out of a total distance of 821 km (510 mi). In the Lincoln area, some visual impacts already exist along the right-of-way of an electrical transmission line paralleled by the Hi-Line Route.

Impacts on Soil

The Hi-Line Route passes through only 88 km (55 mi) of land with high potential for soil erosion, out of a total distance of 821 km (510 mi). Erosion would be particularly severe on steep mountain slopes and in local badland areas on the plains.

Impacts on Aquatic Life and Habitats

The primary advantages of the route are that it avoids crossing the Blackfoot mainstem and it avoids two Missouri River crossings. To do this, however, the Hi-Line Route crosses a number of other streams with considerable fisheries value. Gold Creek, Belmont Creek, Blanchard Creek, Cottonwood Creek, Monture Creek, the North Fork of the Blackfoot River, Arrastra Creek, the Landers Fork of the Blackfoot, and Alice Creek are all class 3 streams within the Blackfoot drainage that are crossed by the Hi-Line Route. The pipeline could heavily affect Blanchard Creek, which the route closely parallels for 8.5 km (5 mi). The route also crosses the Clearwater River (class 2). However, the combined total-flow volume of these waterways is not as high as the Blackfoot where it is crossed by NTPR. Two pump stations on the Blackfoot, one at Rainbow Bend and one above Lincoln, would be required for the Hi-Line Route.

East of the Divide, the Hi-Line Route crosses class 3 reaches of the Dearborn, Teton, Marias, and Milk rivers and of the West Fork of the Poplar River. The Sun River is crossed near Great Falls where, although ranked class 4, it is still a large stream (20 m^3/s or 735 ft^3/s mean annual discharge). The Dearborn and Sun are basically trout fisheries, while the other waterways are warm-water fisheries. The impacts of the Milk River crossing could be mitigated by regulating the flow out of Fresno Reservoir so that discharge was relatively low during construction time. Several of these waterways may possibly be directionally drilled. None of the pump stations east of the Divide should present a risk to aquatic life.

Impacts on Ground Water

The Hi-Line Route crosses 18, 80, and 115 km (11, 50, and 93 mi) of land in ground-water risk categories 5, 4, and 3, respectively. The highest risk areas (category 5) are mainly in the valleys west of the Continental Divide and at the major river crossings.

Impacts on Vegetation and Land Productivity

A considerable amount of forest land is crossed in the Blanchard Creek and Ovando-Rogers Pass areas. In the Lincoln-Rogers Pass area, the right-of-way may be shared with a powerline. This route would affect less highly productive timberland than NTPR or the DNRC Modification Route, but would involve more riparian cottonwood forest stands. The Hi-Line Route crosses by far the most dry cropland and the greatest total amount of cropland of all eastern routes.

Impacts on Wildlife and Habitats

The Hi-Line Route lies as much as 320 km (200 mi) north of NTPR, crosses substantially different wildlife habitats, and affects different species. For example, the Hi-Line Route crosses far less sage grouse habitat than NTPR. However, since this route crosses the glaciated pothole region north of the Missouri River, it would affect far more high-quality waterfowl habitat than any of the other routes. The Hi-Line Route crosses the least amount of sharp-tailed grouse habitat, mule deer winter range, and pronghorn winter range of all possible routes, but crosses the greatest amount of white-tailed deer severe winter concentration areas. It also crosses severe winter concentration areas of white-tailed deer along the North Fork of the Blackfoot River and the Marias River; of mule deer and elk on the east slope of the Rockies east of Rogers Pass; of mule deer along the Teton and Marias rivers and north of Malta; and of pronghorn north of the Dearborn River, south of Crown Butte, and north of Malta. A considerable amount of proposed "critical" grizzly bear habitat (USFWS 1976) is crossed west of Lincoln and in the vicinity of Rogers Pass.

While much of the route traverses potential raptor nesting habitat, the only known nest site which would be affected is a bald eagle nest west of Ovando. A heron rookery is located near the route northwest of Havre. Just west of the North Dakota border, the Hi-Line Route passes near the Medicine Lake National Wildlife Refuge which is an important waterfowl production area and which has been used as a stopover area by whooping cranes (an endangered species) during eight of twenty migration period from 1968 to 1977 (six spring and two fall migrations). A major oil spill in this area could result in oil traveling downstream into Medicine Lake.

Impacts on Climate and Air Quality

Three PSD class I areas are within 48 km (30 mi) of the Hi-Line Route. These are the Bob Marshall/Scapegoat Wilderness, north of the Ovando-Lincoln area; Gates of the Mountains Wilderness, south of Great Falls; and Medicine Lake National Wildlife Refuge, in northeastern Montana. Great Falls is the only metropolitan area along the route and is the only area with a significant amount of air quality data. The Great Falls central business district has been designated nonattainment for TSP. Scobey has limited data records, but the remainder of the Hi-Line Route is largely unmonitored; it is believed to have an overall air quality cleaner than national or state standards.

The only documented major emission sources along the route are two grain processing plants and a local oil refinery in the Great Falls area. Since the majority of this route traverses sparsely populated regions, existing urban pollutants should be minimal.

Raynesford Route

This route is identical to the Hi-Line Route from Bonner to Birdtail Butte, west of Cascade. There it turns east and passes near Raynesford, Denton, Christina, Roy, and Wild Horse Lake, to join the DNRC Modification Route at Mosby.

Terrain, Engineering, and Hydrologic Constraints

The Raynesford Route would encounter the same construction difficulties as the Hi-Line Route (see p. 133).

The Missouri River crossing at Bainville could be done by conventional trenching or bridging, with no obvious engineering problems. However, directional drilling of this crossing may be feasible and could be further investigated by NTPC.

Earthquake Hazards

Earthquake hazards on this route are identical to those on the Hi-Line Route (see p. 133).

Geologic Concerns and Mineral Resources

Geologic hazard areas are identical to those on the Hi-Line Route (see p. 133). The Raynesford Route does not cross any strippable lignite.

Impacts on Land Use: Legal Constraints

No legal constraints along this route have been identified.

Impacts on Land Use: Specially Managed Areas

The Nature Conservancy easement and Clearwater Junction (Concave) SCS near-pristine area could be avoided by centerline adjustment. The Clearwater Game Range can be crossed, while the BLM Cat Creek Wilderness Study area cannot.

Impacts on Land Use: Compatibility with Existing Corridors
The Raynesford Route would utilize 276 km (172 mi) of existing corridors.

Impacts on Land Use: Linear Patterns
This route has many paved and unpaved road crossings; however, the impacts would be negligible due to the rural nature of the area. Only one irrigation ditch is crossed.

Impacts on Land Use: Site Patterns
No industrial areas are crossed by the Raynesford Route, and the urban and residential areas total less than 2 km (1.2 mi). Impacts would be negligible.

Impacts on Social and Economic Concerns
The Raynesford Route would generate lodging demands in Helena for a shorter period than would NTPR and the DNRC Modification Route. As in the case of NTPR, significant lodging shortages would probably occur when construction is out of commuting range of Helena and Great Falls; Lewistown could be expected to alleviate part of the shortfall for a two-to-three month period. Shortages would begin in March 1980, and continue through February 1981, if the present construction schedule is adhered to.

Land productivity lost for this route would be an estimated $178,800 during construction, and $138,400 over the twenty-year operating life of the line. Estimated Montana employment would be 283 person-years during construction; there would be fifty-seven jobs going to Montanans out of approximately 120 direct and induced total jobs during pipeline operation. Total property tax revenue would be an estimated $174 to $338 million.

Impacts on Cultural Resources
Impacts will not be known until an intensive inventory is done.

Impacts on Visual Quality
Potential impacts on visual quality would not differ from those described for the Hi-Line Route (see p. 134).

Impacts on Soil
This route goes across 172 km (107 mi) of land with high potential for soil erosion, out of a total distance of 816 km (508 mi).

Impacts on Aquatic Life and Habitats
The primary advantages of the Raynesford Route over NTPR are that it would not affect Canyon Ferry Reservoir or the North Fork of the Musselshell, and that it avoids crossing the Blackfoot River. This route would have the same impacts to the Blackfoot drainage as would the Hi-Line Route, but it does not avoid two Missouri River crossing as does that route.

After leaving the Hi-Line Route and before joining NTPR, the Raynesford Route crosses the Missouri River, the Smith River, Belt Creek, and the Judith River. The latter three are class 3 fisheries. The Smith River and Belt Creek are trout fisheries. In the crossing area, the Judith River is primarily a sauger fishery. The Missouri River is ranked as class 2 at the Raynesford Route crossing near Great Falls; this compares with the class 1 ranking the river has at the crossing site shared by NTPR and the DNRC Modification Route.

Impacts on Ground Water
The Raynesford Route crosses 24 km (18 mi) of land in ground-water risk category 5 (highest risk), 81 km (50 mi) in category 4, and 67 km (42 mi) in category 3.

Impacts on Vegetation and Land Productivity
Impacts from the Raynesford Route differ from those of the Hi-Line Route only in that it crosses the least amount of irrigated cropland of all routes (see p.).

Impacts to Wildlife and Habitats
In the northern foothills of the Judith Mountains, the Raynesford Route crosses an area of severe winter concentration of mule deer, white-tailed deer, and pronghorn, as well as excellent sharp-tailed grouse habitat containing many leks. Other pronghorn severe winter concentration areas are found north of St. Peter, east of Cascade, and near Wild Horse Lake. South of Armington are severe winter concentration areas for mule deer. Between Wild Horse Lake and Mosby, some excellent sage grouse habitat is crossed, and four known strutting grounds are approached within 1 km (0.6 mi). Like the Hi-Line Route, the Raynesford Route includes proposed grizzly bear "critical" habitat in the Lincoln area. It crosses the most mule deer winter range but the least mule deer severe winter concentration areas of all alternatives east of Bonner. Although it crosses the least amount of important waterfowl habitat, the Raynesford Route crosses the greatest amount of mountain grouse, prairie grouse, and ring-necked pheasant habitat, pronghorn severe winter concentration areas, and white-tailed deer winter range.

Impacts on Climate and Air Quality
Two PSD class I areas, the Bob Marshall/Scapegoat Wilderness and the Gates of the Mountains Wilderness, are within 48 km (30 mi) of the Hi-Line Route. Overall impacts along this route, which crosses a sparsely populated area, would be negligible.

St. Ignatius Route

This route is identical to the present NTPR from Idaho to Weeksville and from Helmville to the North Dakota border. Between Weeksville and Helmville, it extends across the lower Flathead River Valley to St. Ignatius, and follows a MPC 230-kV transmission corridor across the Mission Mountains to Ovando, joining NTPR at Helmville. This route will be discussed in its entirety.

Terrain, Engineering, and Hydrologic Constraints
Impacts would be identical to NTPR west of Bonner from the Idaho border to Weeksville, and east of Bonner from Helmville to the North Dakota border. The Jocko Pass area in the Mission Mountains would be a major mountain crossing. The terrain is high and rough, and construction would be difficult on the west side of the pass. This difficulty, however, is offset by the remainder of the route, which generally follows more gentle, rolling terrain.

The stream crossings on this route would present no special construction difficulties; however, the Flathead, Clearwater, and Blackfoot rivers and Prospect Creek have high environmental value, and construction across them would have to be done carefully.

Earthquake Hazards
Besides passing the Hope Fault (see p. 125), the St. Ignatius Route passes through a zone of recent earthquake activity north of Moiese on the Flathead River. No active faults have been mapped there. This route also crosses the St. Mary's Fault, which appears to be seismically active between Seeley Lake and Lincoln. No Recent (last ten thousand years) surface displacements are known along its length. The fault was, however, actively displaced at the ground surface prior to two million years ago, and possibly during the period of two million to ten thousand years ago.

The St. Ignatius Route also passes through the Nevada Valley and through the Helena and Townsend areas; earthquake hazards would be as described for NTPR. If the St. Ignatius Route is selected, design modification and field investigations would be needed at the crossing of St. Mary's Fault, in the Nevada Valley, in the Helena and Townsend areas, and possibly at the crossing of the Hope Fault.

Geologic Concerns and Mineral Resources
There are 0.8 km (0.5 mi) of cliffs and steep sideslopes on this route, almost all found in the Jocko Pass area east of St. Ignatius. No potential landslide or slump areas were identified, however, if this route is chosen, a careful search for them during centerline studies in the Thompson Pass and Jocko Pass areas may reveal some.

The St. Ignatius Route crosses a total of 34 km (21 mi) of hard bedrock which would require blasting to excavate the pipe trench.

Impacts on Land Use: Legal Constraints
The Confederated Salish-Kootenai Tribal Council would have to approve an easement for the proposed pipeline. To date, the Council has twice rejected NTPC's proposal.

Impacts on Land Use: Specially Managed Areas
The RARE II area (Patrick's Knob-North Cutoff) along this route may be crossed, as could the Clearwater Game Range. The SCS near-pristine area (Helmville Center) could be avoided. The tribal sacred area is part of the Reservation and crossing would involve Council approval.

Impacts on Land Use: Compatibility with Existing Corridors
The St. Ignatius Route would make use of 267 km (167 mi) of existing corridor.

Impacts on Land Use: Linear
Although the St. Ignatius Route has many road crossings, both paved and unpaved, impacts would not be significant. This route crosses sixteen irrigation ditches.

Impacts on Land Use: Site Patterns
This route involves no industrial area and 1 km (0.6 mi) of urban area. There is a relatively large amount of residential land (10 km or 6 mi) involved. Impacts would not be major.

Impacts on Social and Economic Concerns
The lodging and population impacts from this route on all communities in Sanders and Lake counties, as well as on Seeley Lake, Ovando, Lincoln, and Drummond would be significant, because Missoula's commuting zone is extremely restricted. The average monthly increase for the ten-month construction period would be about 390 persons. With the present schedule, housing shortages would take place in June and July (182 and 246 units per night, respectively) during the tourist season in Sanders and Lake counties. Seeley Lake, Ovando, and Lincoln would experience population increases ranging from 5 persons in February to 627 persons in July. The housing shortage would begin to occur in April near Seeley Lake.

Estimated land productivity lost for the St. Ignatius Route would be $187,200 during the construction phase and $275,000 during pipeline operation. Montana employment would be an estimated 381 person-years during construction, and fifty-seven jobs during pipeline. Total property tax revenues for the route would be an estimated $164 to $320 million over the life of the project, assuming current tax rates.

Impacts on Cultural Resources
Although sites are known to exist along this route, the impacts cannot be determined until an intensive inventory, including subsurface testing, is completed prior to construction.

Impacts on Visual Quality
The St. Ignatius Route has approximately the same potential impacts to visual quality as do any of the other routes. Across the Jocko Pass area, the route roughly parallels an existing cleared right-of-way of an electric transmission line; thus the visual impact of the pipeline would be lowered. The area west of Jocko Pass is managed as a wilderness by the Confederated Salish-Kootenai Tribes.

Impacts on Soils
The St. Ignatius Route crosses 239 km (149 mi) of land with high potential for soil erosion, out of a total distance of 1,020 km (634 mi). Erosion rates would be particularly high in the mountains, where there are steep slopes, a short growing season, and high precipitation relative to the drier valleys and the plains. Also there would be high erosion rates in local badland areas on the plains.

Impacts on Aquatic Life and Habitats
Streams within the Reservation have not been ranked by DFWP. Rankings were subjectively given by DNRC and are not directly comparable to classifications of streams off the Reservation. NTPR does not closely parallel a class 1 or 2 stream. The most serious impacts on the Reservation would be at the Flathead River crossing, the two Little Bitterroot crossings, and the encroachment and multiple crossing of the South Fork of the Jocko. A pump station would also be located on the South Fork of the Jocko. Other impacts would be as described for NTPR west of Bonner from the Idaho border to Weeksville, and NTPR east of Bonner from Helmville to the North Dakota border.

Impact on Ground Water
The St. Ignatius Route crosses 44 km (27 mi) of land in ground-water risk category 5, 230 km (144 mi) in category 4, and 85 km (53 mi) in category 3. The category 5 areas include the Helena Valley, the crossings of major rivers, and the Placid Lake area.

Impacts on Vegetation and Land Productivity
The St. Ignatius Route would affect more forest land than any route combination. Much of the forest crossed is in the St. Ignatius-Clearwater Junction area, where an existing powerline right-of-way could conceivably be used. Since forest types could not be broken down by productivity class within the Reservation, estimations of the relative impact of this route on highly productive habitat types cannot be made. Highly productive vegetation types probably occur where the route crosses the Mission Mountains.

Impacts on Wildlife and Habitats
The tabulated data for the portion of this route crossing the Flathead Indian Reservation were obtained by different methods and are of different reliability; hence, they are not directly comparable to the other tabulations.

The St. Ignatius Route crosses the Flathead River between the National Bison Range and the Ninepipe National Wildlife Refuge, an area important to many species of water and upland game birds, big game animals, and raptors. Between St. Ignatius and Placid Lake, grizzly bear habitat is crossed, including some areas designated as "critical" habitat by the USFWS (1976) pursuant to Section 7 of the Endangered Species Act of 1973. An area of white-tailed deer severe winter concentration is crossed adjacent to the Clearwater River crossing, and a recently active bald eagle nest is approached west of Ovando.

Other impacts would be as described for NTPR west of Bonner from the Idaho border to Weeksville, and for NTPR east of Bonner from Helmville to the North Dakota border.

Impacts on Climate and Air Quality
Although air quality along this route is generally good, it is influenced by the Missoula Valley which has been designated nonattainment because of several emission sources.

OTHER ROUTES

Several other routes were identified which are less suitable for pipeline construction. Resource information for most of these has been compiled and tabulated by DNRC and is on file in the Helena office. Information was not gathered for the USFS Driveway Ridge Route or the USFS Ninemile Routes A and B because all were proposed after inventory data was gathered. These will be addressed in the final EIS. The Interstate 90 route was dropped from consideration before tabulation began. The routes are described below and are shown on map 1, p. 12.

West of Bonner

USFS Ninemile Routes A and B
On May 11, 1979, the USFS submitted to DNRC an evaluation of NTPR in the Ninemile area (Siegel Pass to Frenchtown) and two alternative routes. USFS Ninemile Route A follows the DNRC Modification Route until 10 km (6 mi) southeast of Siegel Pass. There it diverges and continues southeast at the base of the mountains, staying approximately 3 to 5 km (2.8 to 3.1 mi) northeast of NTPR. It joins NTPR east of Frenchtown. Route B is identical to A until Sixmile Creek, where it turns south and joins NTPR 8 km (5 mi)

west of Frenchtown. In its corridor analysis and evaluation, the USFS concluded that NTPR was the best in terms of overall environmental impact and that Route A was the least desirable. This difference is due primarily to impacts on wildlife and water quality. Route A would affect more deer and elk winter range, has a higher risk of sedimentation, and has greater stream crossing hazards. Route A would, however, cross the least amount of private land and the most state and federal land of the three alternatives.

Lookout Pass Route

DNRC originally considered Lookout Pass, elevation 1,440 m (4,725 ft), as a possible entry point from Idaho. Lookout Pass is 40 m (134 ft) lower than Thompson Pass and is crossed by two railroad lines, as well as by Interstate 90. NTPC and the state of Idaho agreed that a Lookout Pass crossing would be unacceptable to Idaho because of conflicts with active mines and with urban congested areas encountered in the Wallace-Mullan region. Additional problems would be encountered in paralleling the relatively steep canyon of the St. Regis River, which would probably have to be crossed several times. Idaho and NTPC agreed on the presently proposed Thompson Pass crossing, which restricted Montana to the same point of entry.

Randolph Creek Route

This route enters that state at Thompson Pass, follows Prospect Creek to the mouth of Crow Creek, and then follows a transmission line right-of-way to join the Lookout Pass Route at Taft. It was omitted primarily because of the rugged terrain and the 1,840 m (6,045 ft) elevation of the pass, which would likely require an additional or enlarged pumping station.

Packer Creek Route

From the Idaho border to the confluence of Crow and Prospect creeks, this route is identical to NTPR. At Crow Creek it proceeds to the southwest, following a ridgeline, then crosses an unnamed pass at 1,690 m (5,550 ft), descends along Packer Creek to the Wabash Mine, and proceeds southeastward following a relatively flat bench to join the Knox Pass Route to Twelvemile Creek. It was omitted primarily because of steep terrain, the height of the pass, the extensive amount of forested land crossed, lack of access, and the crossing of RARE II area I-790 near the head of Packer Creek.

USFS Driveway Ridge Route

This route was proposed by the USFS to DNRC on March 9, 1979; there was not time for a detailed analysis. The route begins at the Thompson Pass entry point and climbs northward along the Montana-Idaho border to Beaver Peak. It proceeds westward, generally following a cleared fire line on Driveway Ridge, joining NTPR 5 km (3 mi) southwest of Thompson Falls. This route satisfactorily avoids the aquatic impact risk associated with paralleling Prospect Creek and, according to the USFS, would have fewer impacts than NTPR to forests (since the existing fire line clearing could be used), recreation, and unique natural resources. However, the Driveway Ridge Route would add 5.8 km (3.6 mi) to the length of the line; increase the overall environmental impact (particularly topsoils and wildlife); and, most importantly, would climb to over 2,010 m (6,600 ft)—an increase in elevation of 540 m (1,780 ft) over NTPR. This increased elevation would probably require additional pumping facilities.

Bigfork Route

Originally proposed by Northern Tier, this route leaves NTPR at Thompson Falls, follows the Thompson River Valley northeast to Thompson Lake, and follows Highway 2 east to Kila. It then proceeds east to Bigfork and follows Highway 83 southeast through the Swan and Clearwater valleys to join the St. Ignatius Route at Ovando. It was deleted because of greatly increased length and high risk of environmental impact, as documented by the USFS (USDA 1979).

Milwaukee Railroad Route

This route is identical to the DNRC Modification Route except from Frenchtown to Bonner, where it parallels the Milwaukee Railroad and the Northern Pacific Railroad near Bonner. Although the route passes through the heart of Missoula and crosses fairly steep terrain a short distance upslope from the Clark Fork east of Missoula, the Missoula County Planning Board suggested that the railroad right-of-way might be used for pipeline construction. It would involve two more Clark Fork crossings than NTPR and numerous road crossings. Congestion currently exists from powerlines and the railroad bed; this would slow construction. If the railroad tracks were removed, construction would be easier. It may be feasible to use the railroad bridges for pipeline crossings.

East of Bonner

Interstate 90 Route

This route is identical to the DNRC Modification Route as far as the Goldcreek area. There it turns south and closely follows Interstate 90 to Deer Lodge and southeast to Billings, where it follows Interstate 94 to Glendive. It then parallels Highway 16 northeast to Sidney and Highway 200 to Fairview, crossing the Missouri River north of Fairview to join NTPR.

The advantages to this route are:

1) New access roads would not be needed so there would be little off-site disturbance.
2) Access for surveillance, maintenance, and spill containment would be excellent, and oil spills would probably be quickly detected by a passing motorist.
3) There would be no need for easements through private property except near the associated facilities.
4) Construction personnel would have fast, easy access to services and cities.
5) There would essentially be no disruption of native vegetation, timber, cropland, wildlife, or residential areas within the right-of-way, and centerline-related inventory studies would not be required.

There are many disadvantages to the Interstate 90 Route:

1) DFWP and the Montana Department of Highways (DH) have expressed strong opposition to this route. A letter from DH, dated January 19, 1979, to DNRC states that "Federal and State regulations have, since shortly after the Interstate was started in Montana, prohibited utility facilities from remaining on or being placed longitudinally within the controlled-access portion of the Interstate right-of-way. Where necessary, utilities may of course cross the controlled-access area."
2) This route is approximately 160 km (100 mi) longer than NTPR east of Bonner.
3) There are more major river crossings on the Interstate 90 Route than on any other route east of Bonner.
4) Medians are usually too narrow to accommodate a typical 27-m (90-ft) wide construction spread.
5) The angle of the fill slopes (typically 6:1) often is too steep to allow normal movement of construction machinery without grading.
6) Damage to the interstate from grading, trenching, and traffic of heavy machinery may occur.
7) Traffic would be disrupted in one or both lanes during the entire construction period.
8) Construction equipment and activity along the interstate would create a serious safety hazard.
9) Pipeline highway crossings are complicated and expensive. Crossings at interchanges would be even more complicated.
10) Many underground municipal utilities would have to be crossed in or near urban areas.
11) The interstate right-of-way could only be used for a portion of the required construction width, and for only a fraction of the length of the highway. Therefore, many of the presumed advantages for this route would be partially or entirely lost.

This route does not offer any net advantage over the routes selected for detailed comparison.

Boulder Route

From Bonner to Drummond, this route is identical to the DNRC Modification Route. It turns southeast at Drummond, crosses the Clark Fork near Deer Lodge, and continues east to cross the Continental Divide north of Blizzard Hill at an elevation of 2,285 m (7,500 ft). It then follows the Boulder River to Boulder, skirts the southern foothills of the Elkhorn Mountains to Radersburg, and crosses the Missouri River to join NTPR 14.5 km (9 mi) southeast of Townsend. This route is not a preferred alternative primarily because of (1) the high elevation of the Continental Divide crossing (which is the highest point of all the considered routes); (2) the steep, rugged terrain bordering the Boulder River; and (3) the narrowness and congestion of the Boulder River canyon near Basin.

Bonner-Bearmouth Route

After crossing the Blackfoot River near Bonner this route parallels Interstate 90 north of the Clark Fork to Nimrod. At Nimrod, the route crosses the Clark Fork and proceeds south of the river to join the DNRC Modification Route at Bearmouth. This segment offers several advantages over the corresponding NTPR segment: it parallels existing highway, powerline, railroad, and pipeline corridors over most of its length; it crosses 15 km (9.4 mi) less forested land; and it crosses much less steep, mountainous terrain, therefore requiring far less road construction. However, it is 2.2 km (1.4 mi) longer, closely parallels the Clark Fork over most of its length, has a higher overall erosion hazard, crosses 6 km (3.8 mi) more irrigated cropland, crosses more winter range of moose, mule deer, and white-tailed deer, and passes through a congested area just east of Bonner.

Helmville Hi-Line Route

This route leaves NTPR 16 km (10 mi) southwest of Helmville and continues northeast past Helmville to join the Hi-Line Route near Kershaw Mountain north of the Blackfoot River. It is not superior to the Hi-Line Route for several reasons: (1) the high elevation—2,010 m (6,590 ft)—and steep terrain of the Garnet Range crossing, (2) the two crossings of the Blackfoot River, (3) an additional length of 4.5 km (3 mi), (4) an additional 8.7 km (5.4 mi) of forested land and 1.3 km (0.8 mi) of irrigated cropland, (5) higher erosion hazard, (6) an additional major river crossing, (7) an additional 10 km (6 mi) without a paved road within 5 km (3 mi), and (8) difficult terrain requiring more rockwork.

Wales Creek Route

Until March of 1979, NTPR extended from the McNamara Bridge to Helmville, crossing the Garnet Range east of Greenough and descending the Wales Creek Canyon into the Helmville area, where it joined the present NTPR. It was dropped primarily because of conflicts with the Wales Creek BLM Wilderness Study Areas.

Rogers Pass Route

This relatively minor alternative is identical to the Hi-Line Route except that, rather than following Cadotte Creek, it follows Highway 200 over Rogers Pass, elevation 1,700 m (5,609 ft). While the maximum elevation of this route is about 120 m (400 ft) lower than the Cadotte Creek crossing, it is not as desirable; the terrain is more rugged along Rogers Pass, visual impact would be high, and traffic would probably be disrupted during construction.

Beaver Creek Route

This alternative is also identical to the Hi-Line Route except near Havre, where it passes south of town rather than north. Although it would reduce the length of the Hi-Line Route by approximately 8 km (5 mi), this route is not favored because it crosses two locally important streams (Beaver and Clear creeks), rugged terrain, and the Milk River downstream from Fresno Dam.

Scobey Route

This alternative is identical to the Hi-Line Route except between Whitewater Creek (north of Nelson Reservoir) and Clear Lake (north of Dagmar). In this region, it lies 16 to 24 km (10 to 15 mi) north of the Hi-Line Route. Although it allows better construction access via Highways 5 and 248, it is 10 km (6 mi) longer and offers no clear advantage over the Hi-Line Route.

Wibaux Route

This route, originally proposed by Northern Tier, cuts off from NTPR near Harlowton and proceeds almost due east past Terry and St. Phillips to the North Dakota border. NTPC eventually dropped this route at the request of the North Dakota Public Service Commission because the pipeline would cross the badlands; the Little Missouri River (North Dakota's only scenic river); national grassland; large coal reserves; and two high-voltage, direct-current ground electrodes (which could potentially disrupt the pipeline cathodic protection system). These crossings would cause reclamation problems in southwestern North Dakota. NTPC also dropped this route to avoid crossing the Yellowstone River.

GLOSSARY OF TERMS

The following terms are defined only as used in this draft EIS.

API gravity
A petroleum industry measure of specific gravity or density. API gravity is expressed in degrees and is related to specific gravity as follows:

$$\text{Degrees API} = \frac{141.5}{\text{Specific Gravity } 60°\text{F}/60°\text{F}} - 131.5$$

A-weighted decibel
See **decibel**.

active fault
As used in the report, a fault that displaces Recent (last ten thousand years) deposits, or has earthquakes related to the fault, or shows evidence of structural coupling to another active fault nearby.

aerial span
Suspended or supported pipe above the ground, usually at a river crossing.

aerosol
Solid or liquid particles less than one micron (10^{-6}m) in diameter suspended in a gas.

aggregate
A construction material, such as sand, gravel, or crushed rock, used in concrete, land fill, or manufacturing processes.

alluvium
Unconsolidated sediment such as sand, pebbles, clay, or silt, or mixtures of these, deposited by rivers or streams.

ambient
Pertaining to the existing surrounding conditions.

aquatic biota
Flora and fauna whose habitat is any body of water.

aquifer
A geologic formation or structure that transmits water in sufficient quantity to supply the needs of a water development.

artesian water
Water confined under enough pressure to cause it to rise above the level where it was encountered by drilling. Flowing artesian wells occur when the pressure is sufficient to force the water above the land surface.

barrel
A volume measurement equivalent to 160 liters (42 U.S. gallons).

benefit
The social value of an increase in well-being, resulting from channeling resources into a specific project.

external benefit
Benefit that accrues to persons other than the purchaser of a product due to purchase or use of a product.

internal benefit
Benefit that accrues to the purchaser of a product due to the purchase or use of a product.

monetary benefit
Benefit that can easily be measured in monetary terms derived from market values.

nonmonetary benefit
Benefit that cannot be readily measured in monetary terms.

bentonite
Soft, highly plastic, porous, light-colored rock or clay consisting largely of colloidal silica and clay minerals (mainly of the montmorillonite group).

berm
An embankment of fill.

block valve
A valve operated by a change in pressure of the material passing through it. Automatically closes a pipeline when abnormal flows occur.

boom (oil)
A floating device to contain oil spills within its boundaries.

buffer strip
A strip of land within which no construction activity takes place.

buried crossing
A subsurface crossing of a road, railroad, stream or other obstacle by the pipeline.

carrying capacity
The optimum number of organisms which the environment is capable of supporting over the long term.

casement (or casing)
A protective covering around the pipe.

cathodic protection
A method of preventing corrosion of steel pipe and components by causing an electrical current to flow between the soil and the pipe.

Cenozoic
See **geologic time**.

centerline
The precise location of the linear center of a pipeline right-of-way, as surveyed and staked on the ground.

coal liquefaction
The manufacture of synthetic petroleum products from coal.

cofferdams
Fill (usually sandbags) placed to prevent the flow of water through an instream construction site.

common carrier
A transportation company or system having state or federal authority to provide public transportation of goods or passengers for a fee. The Northern Tier Pipeline would be a common carrier.

consumer surplus
Benefit consumers receive from purchasing goods at market value that they would have willingly purchased at a higher price.

corridor
A linear study area approximately 0.5 km (0.3 mi) to 32 km (20 mi) in width, within which a pipeline route could conceivably be located.

cost
The social value foregone when resources are designated for a particular use, thereby excluding other economic activities.

external cost
Cost not paid by the owners or users of a good or service, but borne by others or the environment.

internal cost
Cost paid by the owner and users of a good or service.

monetary cost
Cost that can easily be measured in monetary terms derived from market value.

nonmonetary cost
Cost not easily measured in monetary terms derived from market values.

critical area
Area where a resource of county-wide, state-wide or national importance is likely to be significantly and adversely affected even if the best available mitigating measures are employed.

decibel
A unit for measuring the relative loudness of sounds, equal approximately to the smallest degree of difference or ordinarily detectable by the human ear. The widely accepted scale for measuring perceived noise, called the "A-weighted decibel scale" and denoted dB(A), commonly ranges up to about 130 decibels, with 0 at the threshold of hearing. An increase of 10 decibels involves a tenfold increase in intensity.

delivery facilities
Facilities that receive consignments of crude oil and deliver them to other pipeline facilities or refineries. These facilities include a control building, control system, a communication tower, a heliport, roadways, lighting, and fencing.

directional drilling
A drilling technique, performed at an angle, for laying pipeline at large stream crossings. The drilling machine simultaneously arcs a tunnel below scour depth of the streambed and pulls pipe casing through the tunnel; pipe is then pulled through the casing.

discharge
The rate at which a fluid flows from a pipe, canal, channel, aquifer, river, or drainage basin expressed as a volume passing a point per unit of time (e.g., cubic meters per second or cubic feet per second).

double ditching
A two-step operation in which the topsoil is first removed from a ditch and stored separately before the subsoil is removed to pipeline grade.

easement
A legal agreement in which a landowner grants the pipeline company the authority to carry on certain pipeline-related activities within a specified area.

construction easement
A legal agreement in which the landowner grants the pipeline company authority to carry out all activities necessary to install the pipeline. Usually granted for a wider parcel of land than the construction right-of-way.

permanent easement
A legal agreement in which the landowner grants the pipeline company authority to carry out pipeline operation and maintenance activities on the land in proximity to the pipeline. Usually granted for a wider parcel of land than the permanent right-of-way.

ecotone
A transitional or edge habitat, composed of a mixture of species characteristic of the communities bordering the edge.

eminent domain
A government's right to take or to authorize the taking of privately owned land for a public use. The owner receives just compensation.

epicenter
The point on the earth's surface that lies directly above the focus of an earthquake.

erosion
The process whereby earth materials are loosened or dissolved and removed from a part of the earth's surface by running water, waves, ice, or wind.

eurytopic species
Species that tolerate wide extremes in environmental conditions.

external load
See **load**.

eyrie
The nest of an eagle or other bird of prey.

fee ownership
A legal agreement that provides a purchaser with all rights, entire property and unconditional power of disposition of a parcel of land, during that person's life.

flange
A circular pipe coupling made in two halves. Each half is welded to a length of pipe, and the two halves are bolted together.

flood plain
A strip of relatively level land bordering a stream that is subject to overflow flooding; thus certain construction activities are regulated or prohibited on it.

flume
(1) An artificial channel. (2) To divert fluids through a flume, as the waters of a stream, in order to expose the sand and gravel forming the bed.

focus
The true center of an earthquake; the point from which seismic waves originate.

fractions of crude oil
The substances that are yielded from the fractional distillation of crude oil. Among these are gasoline, naptha, and benzene.

fugitive dust
Suspended particles that have become airborne due to wind or man's activity.

gabion
A wire mesh cage filled with heavy material, usually rocks; used to prevent erosion and stabilize streambanks.

geologic time
System for measuring time in the physical history of the earth.

ERA	PERIOD	EPOCH	YEARS AGO
		Recent or Holocene	the last 10,000 years
	Quaternary	Pleistocene	2 million
		Pliocene	7 million
Cenozoic		Miocene	26 million
	Tertiary	Oligocene	38 million
		Eocene	54 million
		Paleocene	65 million
	Cretaceous		135 million
Mesozoic	Jurassic		190 million
	Triassic		225 million
	Permian		280 million
	Pennsylvanian		325 million
Paleozoic	Mississippian		345 million
	Devonian		400 million
	Silurian		430 million
	Ordovician		500 million
	Cambrian		600 million

Precambrian — Precambrian time represents 85% of the earth's history thus far.
NOTE The scale of this figure does not represent the duration of periods, epochs or eras.

grain size

clay
A grain having a diameter less than 1/256 mm (0.00016 in).

silt
A grain having a diameter between 1/256 and 1/16 mm (0.00016 and 0.0025 in).

sand
A grain having a diameter between 1/16 to 2 mm (0.0025 and 0.08 in).

gravel
A grain having a diameter between 2 and 4 mm (.08 and .16 in).

pebble
A grain having a diameter betwen 4 and 64 mm (.16 and 2.5 in).

cobble
A grain having a diameter between 64 and 256 mm (2.5 and 10 in).

boulder
A rock mass having a diameter greater than 256 mm (10 in).

habitat
An area having environmental conditions which support or could support natural populations of a particular species.

hard plug
A trenching technique used at streams to prevent silty water in the trench from entering the stream. A segment of the trench adjacent to the stream is left unexcavated (until the pipe is laid) to block the movement of sediments.

herbivore
An animal that feeds primarily on plants.

horizontal drilling
A drilling technique for laying pipeline at stream crossings. A vertical shaft is excavated on either side of the stream, then a horizontal shaft is drilled that connects to the vertical shafts. Simultaneously with drilling, casing is placed in the tunnel, then pipe is pulled through the casing.

hydrocarbon
A compound that contains mostly hydrogen and carbon.

hydrostatic test
The application of a predetermined fluid pressure to the interior of a pipe to test its ability to withstand that test pressure over a prescribed time period.

impact
Any change in the biological, cultural, or physical situation as it exists that would result, in this case, from the construction, operation, or abandonment of the Northern Tier Pipeline.

intensity
A measure of the effect of earthquakes and earth tremors on humans and human structures. The Modified Mercalli Scale measures intensity.

internal loading
See **load**.

large-diameter pipeline
Any pipeline over 76 cm (30 in) in diameter.

lateral migration
Removal through erosion of bank material, soils, and rock adjacent to stream channels, resulting in a lateral channel shift.

lek
A communal courtship area on which several males (usually grouse) hold courtship territories to attract females.

liquefaction
In geology, a temporary transformation of soil or sediment into a fluid mass due to shock or strain, usually where the presence of water has increased pore fluid pressure in the soil. See also **coal liquefaction**.

load
(1) Ratio of the average power to the maximum power. (2) The amount of current supplied by an electrical power source. (3) Stress on pipe which may result from external sources, such as wind or ice, or internally from fluid pressure.

magnitude
A measure of the strength of an earthquake or the strain energy released by it as determined by seismograph measurements; magnitude measures energy. The Richter scale measures magnitude. Intensity, a measure of the effect the released energy has on humans and human structures, should not be confused with magnitude.

mandril
A support placed within a pipe to prevent flattening during pipe bending.

material site
Any site where earth materials such as gravel, sand, or topsoil are obtained.

meander
Dynamic curvature in river and stream courses, caused by lateral migration, resulting in a winding or sinuous pattern.

metric system
A decimal system of weights and measures.

Metric Equivalents

Length

inch	2.54 centimeter
inch	0.0254 meter
foot	0.3048 meter
mile	1.609 kilometer

Area

acre	0.4047 hectare

Volume

Gallon	3.785 liter
Barrel (42 U.S. gallons)	0.003785 (3.785 × 10^3) cubic meter

Flow

cubic foot per second (ft^3/s)	0.02832 cubic meter per second (m^3/s)

Weight

pound	2.2046 kilogram
ton	0.9072 tonne

Temperature

F degrees	5/9 C degrees + 32

mitigating measure
An action that can be taken to reduce or eliminate damage or potential damage.

Northern Tier States
Washington, Oregon, Idaho, Montana, North Dakota, Minnesota, Michigan, Wisconsin, Illinois, Indiana, and Ohio.

periphyton
Aquatic organisms that attach themselves to underwater surfaces such as rocks or aquatic plants.

person-month
A unit of labor; one person employed for one month.

phenological response
The cyclical behavior of organisms' time of flowering, leafing, and so on in relation to the climate or to a disruption of climatic conditions.

pipeline mile
One mile of pipe length. Usually longer than one surveyed mile, since the pipe must follow the contour of the ground.

pipe staging
The sequence of events necessary to prepare the pipeline for operation, i.e., stringing the pipe along the route, bending, welding, coating inspection, placement, and so on.

plankton
Suspended floating or weakly swimming microscopic plant and animal life, found in bodies of water, that provide the basis for the aquatic food chain.

Pleistocene
See **geologic time**.

power
Force multiplied by distance and divided by time; performance of a given amount of work in a specified time.

Precambrian
See **geologic time**.

pressure head
The height to which a liquid is raised by a pump.

pressure piping
Pipe used for conveying fluids at normal or elevated temperature and pressure.

primary production
The production of glucose and related organic compounds by chlorophyll-bearing plants called primary producers.

pump stations
Stations along the pipeline route that provide the power to move the oil along the route.

Q
The hydrologic abbreviation for discharge. See **discharge**.

Quaternary
See **geologic time**.

radiographic testing
The use of X-rays to produce an image to determine weld integrity.

raptor
A bird of prey, such as a falcon, hawk, or eagle.

Recent
See **geologic time**.

revetment
A retaining wall.

Richter scale
Nonlinear scale used to measure the magnitude of an earthquake.

riffle
Fast section of a stream where shallow water races over stones and gravel; riffles usually support a greater variety of bottom organisms than other sections of the stream.

right-of-way
The strip of land appropriated by a pipeline company through easement, condemnation, or fee ownership.

construction right-of-way
The strip of land, appropriated by a pipeline company, that is actually disturbed during construction of a pipeline; usually wider than the permanent right-of-way.

permanent right-of-way
The strip of land appropriated by a pipeline company to handle maintenance activities during operation of the pipeline; usually narrower than the construction right-of-way.

riparian
Pertaining to the bank or shore of a stream or lake.

riprap
Loose rock used to armor part of streambanks, shorelines, or artificial embankments against erosion.

route
The general location of a pipeline right-of-way, subject to adjustments of 1.6 km (1 mi) or more during centerline location.

rupture strength
That stress at which a material breaks or ruptures.

salmonid
A fish of the salmon family (Salmonidae), such as salmon, trout, char, and whitefish.

saturation zone
Any subsurface region in the earth in which pores in the rock or sediments are full of water.

sediment
Fragmented material that originates from weathering and erosion of rocks and is transported by, suspended in, or deposited and accumulated in beds by water, air, gravity, or ice.

sedimentation
The process of depositing sediment.

seismic wave
An earthquake-caused wave that travels within the earth or along the earth's surface.

sensitive area
Area where (1) a resource of county-wide, state-wide, or national importance is likely to be significantly and adversely affected if not adequately mitigated; (2) terrain or other constraints would require costly or unconventional construction techniques or greatly increased construction time and costs; or (3) risk of damage to the pipeline is high.

shear
A deformation of material under stress; adjacent areas are displaced in opposite directions parallel to each other.

siltation
The deposition or accumulation of silt that is suspended throughout a body of water; often includes sedimentary particles ranging in size from colloidal clay to sand.

silt curtain
A turbidity control device consisting of fabric that can be placed in bodies of water to prevent the flow of silt.

single ditching
Removal of topsoil and subsoil from the pipeline trench in one operation.

slash
Limbs, brush, bark, broken uprooted trees, and other debris that are left as residue after clearing the right-of-way.

soft plug
A trenching technique used at stream's edge to prevent silty water in the trench from entering the stream. A portion of the excavated trench adjacent to the stream is filled before pipelaying to block the movement of sediments, then excavated again to lay the pipe.

soil colloids
Organic or inorganic matter in soils having small particle size and a correspondingly large surface area per unit of mass.

soil horizon
A layer of soil that is distinguishable from adjacent layers by characteristic physical properties (such as structure, color, or texture) or by chemical composition.

special management area
Unit of land administered in such a way that some land uses are prohibited or regulated.

stream reach
Specified length of stream channel between two points on a river.

stress
(1) The force per unit area acting on a body. (2) A condition in an organism caused by unfavorable environmental conditions.

support facilities
Facilities necessary to complete a pipeline but not used in the actual construction of the pipeline. These include facilities which provide communications, electrical power, fire protection, waste treatment, and disposal.

surge relief tank
A tank that receives quantities of oil from a pipeline through a relief valve.

swarm
A series of minor earthquakes, none of which can be identified as a major shock.

syncline
A fold in rocks in which the layers dip inward from both sides towards a central axis; a cross section of any one layer would reveal a U-shape or some variation of it.

tariff
A fee charged by a pipeline company or other transportation facility, usually per barrel, to transport crude oil or refined products.

telescoped line
A pipeline in which wall thickness varies as internal and external stresses demand. The wall is made thicker in certain stretches to resist deformation.

temperature inversion
A stable atmospheric condition in which warm air is above cooler air.

Tertiary
See **geologic time**.

throughput
The quantity of crude oil or other product transported by pipeline in a given time, usually measured in barrels per day.

topography
Natural and human-made features of an area, such as hills, lakes, and valleys, that describe the configuration of the earth's surface.

trenching
The act of excavating earth from a relatively narrow path into which pipe can be laid.

ultrasonic testing
Testing of a solid substance for flaws, such as holes or cracks, by means of high-frequency sound waves that are transmitted into the substance and reflected off the flaws.

viscosity
Internal friction in a fluid, caused by molecular attraction, that creates the resistance of a fluid to flow.

wettability
The ability of a liquid to form a cohesive film on a surface.

yield strength
A stress value supplied and guaranteed by a steel manufacturer; the minimum stress at which a specified deformation of the steel will occur. The value is the basis for all design strength calculations.

LIST OF ABBREVIATIONS

ANSI	American National Standards Institute
API	American Petroleum Institute
BLM	Bureau of Land Management
bpd	barrels per day
C degrees	Centigrade degrees
cm	centimeter
d	day
DFWP	Department of Fish, Wildlife, and Parks
DH	Department of Highways
DHES	Department of Health and Environmental Sciences
DNRC	Department of Natural Resources and Conservation
DPA	Description of the Proposed Action
DSL	Department of State Lands
dwt	dead weight tons
EIS	environmental impact statement
EPA	Environmental Protection Agency
F degrees	Fahrenheit degrees
FEA	Federal Energy Administration
ft	foot
ft^2	square foot
ft^3	cubic foot
gal	gallon
ha	hectare
in	inch
kg	kilogram
kV	kilovolt
L	liter
m	meter
m^3	cubic meter
MCA	Montana Codes Annotated
MEAC	Montana Energy Advisory Council
MEPA	Montana Environmental Policy Act
MERDI	Montana Energy and MHD Research and Development Institute
mg/L	milligrams per liter
mi	mile
MPC	Montana Power Company
MW	megawatt
NBP	Northern Border Pipeline
No.	number
NTPC	Northern Tier Pipeline Company
NTPR	Northern Tier Pipeline Route
NTSB	National Transportation Safety Board
p.	page
pp.	pages
PSD	Prevention of Significant Deterioration
RARE	Roadless Area Review and Evaluation
s	second
SCADA	Supervisory Control and Data Acquisition System
SCS	Soil Conservation Service
SPCO	State Pipeline Coordinator's Office
TAPS	Trans Alaska Pipeline System
U.S.	United States
USDA	United States Department of Agriculture
USDOE	United States Department of Energy
USDI	United States Department of the Interior
USDOT	United States Department of Transportation
USFS	United States Forest Service
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
yr	year

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Policy Guidance and Final Approval:
Ted J. Doney, Director, DNRC

Project Direction:
Bob Anderson, Administrator, Energy Division
Randy Moy, Planning Bureau Chief
Dave Janis, Project Manager

Research and Writing:
Ray Breuninger, Physical Sciences Coordinator
Larry Nordell, Cultural Sciences Coordinator
Larry Thompson, Biological Sciences Coordinator
Tim Skeel, Economist
Fred Robinson, Aquatic Biologist

Technical and Policy Review:
Carole Massman, Frank Culver and Wayne Wetzel, Special Staff
Don MacIntrye, Chief Legal Counsel

Editing:
Kristine Ellis, Editor
David Lambert, Editorial Supervisor
Lee Shelton and Shari Meats, Editorial Assistance

Typing and Clerical Assistance:
Pam Goddard, Clerical Supervisor
Gerri Radosevich, Map Clerk

Graphic Arts:
D. R. Breiby, Layout and Design
D. C. Howard, Maps and Cover Design
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Gary Wolf, Typographic Supervisor
Patti McCarthy, Typesetting

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